



REPORT OF THE IRRIGATION AND POWER TEAM

ON

KOYNA PROJECT

(BOMBAY STATE)



COMMITTEE ON PLAN PROJECTS

GOVERNMENT OF INDIA

NEW DELHI

FEBRUARY 1959

LETTER OF TRANSMITTAL

No. COPP/IP/45/58

RAJ BHAVAN,

CHANDIGARH

January 17, 1959.

MY DEAR PANTJI,

I have great pleasure in forwarding to you the Report of the Team for Irrigation and Power on Koyna Project. The Report is the result of close study of all relevant facts and observation of necessary matters. The method followed was to consult the Project Authorities concerned at every step, the dominant thought being to do everything in close cooperation and in a spirit of joint endeavour.

2. As the work of the Team proceeded, interim reports were submitted from time to time and thus no time was allowed to be wasted for such recommendations being implemented as were agreed to and approved. The Report has the concurrence of the Consultative Committee which was appointed to advise the Team on technical questions. The main recommendations of the Team were discussed with the concerned State Authorities and the Draft Report was discussed with them before it was finalised by the Team. The reactions of various concerned authorities, are being placed in the form of a tabular statement in accordance with Memorandum No. COPP/4/(14)/58, dated the 13th May 1958, of the Committee on Plan Projects to the Leader of the Irrigation and Power Team.

3. I take this opportunity of thanking you for the close personal interest you have taken in the investigation and for the guidance you gave me throughout the period of investigation and enquiry. I take this opportunity to thank the Secretary of the Committee on Plan Projects whose cooperation was invaluable and also to place on record the help and guidance which the Members of the Consultative Committee made available to the Team throughout.

With regards,

Yours sincerely,

N. V. GADGIL

SHRI GOVIND BALLABH PANT,
MINISTER FOR HOME AFFAIRS,
NEW DELHI

CONTENTS

CHAPTER No.	SUBJECT	PAGES
	<i>PREFACE</i>	(i) to (iii)
I	HISTORY AND SCOPE OF PROJECT	1-4
II	ADMINISTRATION	5-9
III	POWER GENERATION AND UTILISATION	10-15
IV	INDUSTRIAL AND IRRIGATION DEVELOPMENT	16-19
V	PHASING OF CONSTRUCTION PROGRAMME	20-36
VI	FEATURES OF DESIGN AND CONSTRUCTION	37-42
VII	COSTS OF PROJECT	43-50
VIII	AGENCIES OF CONSTRUCTION	51-59
IX	SUMMARY	60-64
	<i>APPENDICES</i>	
I	PATIENT FEATURES OF KOYNA HYDEL PROJECT	65-67
II-A	CONSTITUTION AND FUNCTIONS OF CONTROL BOARD	68-69
	B—Rules of Business	70-71
	C—Emergency Procedures	72
	D—Functions of Financial Adviser	73-74
III	MINUTES OF MEETING BETWEEN BOMBAY AND MYSORE ENGINEERS REGARDING STORING KOYNA WATERS	75-79
IV	CORRESPONDENCE BETWEEN THE TEAM AND CHIEF ENGINEER KOYNA REGARDING : A—Concreting Plant of Koyna Dam.. .. .	80-90
	B—Pressure Shafts	91-93
V	SHRI S. L. KIRLOSKAR'S PROPOSAL TO CONSTRUCT THE DAM TO 2ND STAGE DIMENSIONS	94-99
VI	CORRESPONDENCE BETWEEN THE TEAM AND THE CHIEF ENGINEER KOYNA REGARDING COST OF CEMENT	100
VII	SUB-COMMITTEE REPORT REGARDING AGENCIES OF CONSTRUCTION	101-103
VIII	ITEM NO. VI OF 17TH MEETING OF KOYNA CONTROL BOARD (APRIL-56) REGARDING UNION MINISTER FOR PLANNING'S VIEWS ABOUT AGENCIES OF CONSTRUCTION	104
IX	LIST OF SOME OF THE CLAUSES ENTERED INTO, AFTER INVITA- TION OF TENDERS	105-108
X	MINUTES OF MEETING WITH BOMBAY GOVERNMENT (23-10-58) AND BOMBAY GOVERNMENT'S VIEWS ON THICKENING OF DAM SECTION TO STORE FULL STORAGE	109-113
XI	STATEMENT OF TEAM'S RECOMMENDATIONS AND OBSERVATIONS ALONGWITH COMMENTS OF THE GOVERNMENT OF BOMBAY .. AND C.W.&.P.C.	114-130

MAPS AND CHARTS

S. No.	SUBJECT	FACING PAGE NO.
1.	INDEX MAP OF KOYNA HYDEL PROJECT	2
2.	GRAPH SHOWING LOAD DEMAND	14
3.	MAP OF KRISHNA VALLEY	18
4.	CROSS SECTIONS OF KOYNA DAM	30
5.	GRAPH SHOWING RESERVOIR CONTENTS & LEVELS (K. R. Ls) ..	32
6.	PHOTOGRAPH OF 6'x3' (DIA) RUBBLE CONCRETE CORE ..	38



PREFACE

The Committee on Plan Projects, set up by the National Development Council, had decided in May 1958 that Koyna and Nagarjunasagar multi-purpose Projects should be studied according to the terms of reference, with a view to securing economy and efficiency in the utilisation of financial and other scarce resources. The Team for Koyna Project consisted of :

Shri N. V. Gadgil

Leader

Shri Balwant Singh Nag,
formerly Member, High Level
Committee on Floods, C.W. & P.C.

Shri M. P. Mathrani,
Chief Engineer (Retd.),
Bihar

Members

The Team was assisted by a Consultative Committee consisting of senior engineers :

Dr. A. N. Khosla, M.P.,
Vice-Chancellor, Roorkee University

Shri N. N. Iengar,
Electrical Adviser,
Hindustan Steel (P) Ltd.,

Shri M. S. Tirumale Iyengar,
Chief Engineer, Hirakud

Shri A. C. Mitra,
Chief Engineer, Irrigation, &
Chief Engineer-in-charge,
Rihand Project. (U.P.)

Shri D.S. Borker worked as Secretary to the Consultative Committee and also to the Irrigation and Power Team.

2. The Terms of Reference which were communicated by the COPP in their Memorandum No. COPP/4/(14)/58 dated the

(ii)

13th May 1958 required that the Team should make a study of various aspects of the two Projects, in particular :—

- (1) The aspects of the Project having a bearing on economy and efficiency with special reference to :
 - (a) Utilisation of trained personnel and materials;
 - (b) Utilisation of machinery and equipment;
 - (c) Construction Plant lay-out;
 - (d) Adequacy of original estimates and designs as evidenced from actual construction of the project;
 - (e) Phasing of construction with a view to studying whether:
 - (i) timely utilisation of benefits accruing from the Project has been ensured;
 - (ii) it is possible to accelerate accrual of benefits; &
 - (iii) benefits could be increased by rephasing the project at this stage;
 - (f) Sufficiency of investigations conducted at the planning stage with a view to the formulation of project estimates;
 - (g) The effect of the above study on the financial results of the project, if any.
- (2) Generally to assess the progress made in construction, the reasons for shortfall, if any, and to suggest measures for improvements in the future;
- (3) To examine the possibility of decreasing dependence upon imported materials and equipment required for the project;
- (4) To examine whether adequate steps have been taken by the authorities concerned for fixing and realising the contemplated water rates, betterment fees and/or any other rates, cesses or taxes; and
- (5) To report on any other aspect that the Team may like, in order to ensure economy and efficiency in the construction of the Project.

3. The Leader and the Members of the Team paid a number of visits to the Koyna Project site during the period, February—October 1958. The main burden of the investigations on Power side of the Koyna Project however fell on Shri N.N. Iengar,

(iii)

Electrical Adviser, Hindustan Steel (P) Ltd. and Member of the Consultative Committee. The Team submitted the report to the Consultative Committee in the beginning of October 1958. It was discussed in detail at a Meeting of the Consultative Committee and certain modifications were made. A copy of the report was forwarded to the Koyna Project Authorities and was subsequently discussed with them. In the light of the decisions taken at that meeting, the report was further modified and was again discussed with the Project Authorities at a Meeting held at Bombay on 6th December 1958. The Report was then finalised. A copy of the final Report was also forwarded to the Chairman, Central Water & Power Commission with a request to communicate any remarks they have to offer. The Team is ~~glad to note~~ that the Central Water & Power Commission are in agreement with its recommendations but have suggested that the load forecasts as prepared by them should not be disturbed.

4. The Team would like to place on record their gratitude to the Koyna Project Authorities for the facilities extended for the conduct of investigations and the spirit of accommodation shown by the Chief Engineers and other concerned officials at all levels. We also take this opportunity to express our thanks to Shri V. T. Krishnamachari, Deputy Chairman and Shri C.M. Trivedi, Member, Natural Resources, Planning Commission for the keen interest evinced by them in the study.

CHAPTER I

HISTORY AND SCOPE OF THE PROJECT

1.1. From the early part of the century, Bombay Government were considering the potentialities of the Koyna basin for irrigation purposes. The House of Tatas were the first to investigate the scheme during 1917 to 1924 purely for Hydro Electric purposes and had prepared estimates for developing 180 MW in three stages to supply power to Bombay area. For various reasons these schemes did not materialise.

1.2. In 1946 the Bombay Government followed this up by authorising the Bombay Electric Grid Department to carry out detailed surveys and investigations and to submit a report on the full possibilities of the scheme. The data already available with Tatas was very helpful in speeding up the investigations.

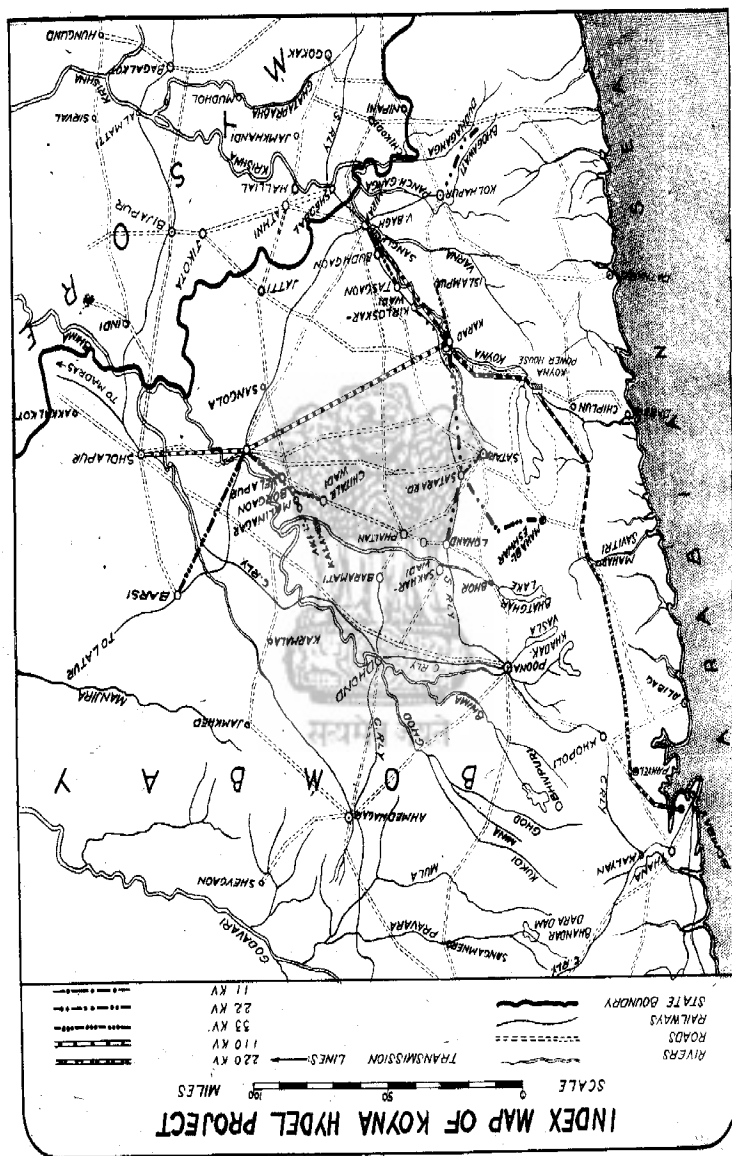
1.3. As Power could be generated by diverting the waters to the Arabian Sea and the load development would take a long time so as to enable consumption of the entire potential, the Government of Bombay who were keen to develop irrigation in the famine stricken district of Bijapur with the Koyna storage appointed a special Committee, headed by Shri N. S. Gupchup, to report on this aspect. The recommendations of this Committee made in 1948 were that the Koyna Valley could yield about 156,000 M. C. Ft. which could be stored by means of a dam about 300' in height, located at Jalkawadi. The Committee had drawn up a scheme, phased in various stages, for the utilisation of this storage towards the generation of power and irrigation of lands in Bijapur District. The total area proposed to be irrigated was of the order of 4,40,000 acres in the first stage, and 7,40,000 in the final stage. The power required for lifting the water in the first stage was of the order of 82,000 KW, load growth of which was spread over a period of 10 years. The Committee recommended that while, in the initial stages, a part of the Koyna Storage should be utilised for irrigating the land in the Bijapur District, in the final development, the waters of the Krishna and Bhima should be harnessed for irrigation purposes and the whole of the Koyna storage should be diverted towards power generation. According to the Committee, the greatest asset possessed by the waters of the Koyna is its static potential and consequent ability to generate cheap hydro-power in bulk. Therefore, they thought it expedient that the Koyna flow should,

in the ultimate stages of development, be entirely reserved for power generations utilising other sources like Krishna and Bhima for irrigation purposes. The various schemes that Government of Bombay prepared thereafter are as below :—

- (i) The first scheme as prepared by the Electric Grid Department in June 1950, was more or less on the pattern recommended in the Gupchup Report viz. to have a 300' high Dam near Jalkawadi to store 156,000 M. C. Ft. of water and a first stage development of power comprising step by step installation of 7 units of 60 MW capacity each from 1956-57 to 1963-64. The final stage development envisaged a total installed capacity of 660,000 KW. The cost of the first stage development was about 52.5 crores.
- (ii) Owing to financial stringency the above scheme could not be implemented and the Government of Bombay decided to curtail the scope of the first stage further. An Experts' Committee under the Chairmanship of Dr. A. N. Khosla was appointed in January 1951 to advise on the types of dam and power house suitable for the scheme and on other problems relating to raising of the dam for further stages of development. The Committee comprised Sarvashri J. L. Savage, C. Marcello, Kristen Friis, M. J. Simonetta, Kanwar Sain and M. L. Champhekar. Shri D. B. Anand who was in charge of preparation and design of the project was the Secretary of the Committee. Meanwhile, when the estimate was being framed, the Planning Commission held an inter-state conference in June 1951, between the erstwhile States of Bombay, Madras, Hyderabad and Mysore, to decide the relative shares of each State in Krishna waters for irrigation and other purposes. It was decided therein that only 67,500 M. C. Ft. of Koyna waters should be diverted westwards to the Arabian Sea. This decision changed the main aspect of the scheme as the scope for power generation was reduced almost to half of the original plan and fresh studies were therefore undertaken. Accordingly, the scheme prepared as per January 1952 Report was to be carried out in 3 distinct stages as follows :—

STAGE I :

- (a) Live Storage for 48,200 M. C. Ft. was to be provided (40,200 M. C. Ft. required for generating 300,000 KW at 60% L. F. and 8000 M. C. Ft. for irrigation in Satara District).



- (b) An underground power house was to be located on the West of the ghats with 4 (eventually 5) generating sets of 60,000 KW each, with the necessary conduit and transmission and receiving systems. The nozzle level was to be at 444 ft above mean sea level. The cost of the scheme was estimated at Rs. 45 crores. The delivery of power was to commence from 1958 onwards.

STAGE II

- (a) Widening and raising of the dam to final section to hold 98,700 M. C. Ft. of water which was considered as the dependable storage based on detailed hydrological studies, was provided 41,000 M. C. Ft, being for irrigation in Satara & Bijapur Districts including evaporation losses and carry overs and rest 57,000 M. C.Ft. for power.
- (b) Extension of power house by installing 4 more units of 60 KW each.

STAGE III.

Installation of another underground power house at 149' above mean sea level to generate 60,000 KW and a power house at the foot of the dam to generate 30,000 KW from the irrigation releases.

- (iii) The Government of Bombay, on further reconsideration, decided to restrict the first stage development only to power development (240,000 KW installed capacity, as required by Bombay area) and accordingly, the scheme was recast in December 1952. The Planning Commission approved this scheme estimated to cost Rs. 33.22 crores and provided Rs. 6 crores to be spent in the First Five Year Plan. The execution of preliminaries etc. was inaugurated in January 1954. But some of the technical details had to be modified as per advice of Swiss Consultants and the rates increased so as to accord with tenders received by then. Accordingly, a revised estimate for Rs. 40.44 crores was proposed for sanction in March 1956. This estimate was pruned to Rs. 38.28 crores by deleting or curtailing some features of an auxiliary nature and administratively approved in Jan. 1957. The scheme as it presently stands is the same as in (ii) above, except that the stage I of the Scheme would provide a dam to store only water required for generation of 240 MW. of electricity, which is 35,950 M. C.Ft. For details of the scheme please refer to Appendix I (Page 65).

1.4. The investigations of the scheme have been generally carried out in a thorough manner. The Technical Hydrological and Economic aspects involved in the design of the various units of the scheme have been studied in great detail and the Team is of the opinion that a successful endeavour has been made to produce an efficient scheme both technically and economically.



CHAPTER II

ADMINISTRATION

2.1 The Koyna Project is administered by Government of Bombay under the advice and guidance of a Control Board set up in June 1954. The composition and functions of the Board are given in Appendix II-A. The Board has further evolved its rules of Business vide Appendix II-B. Lately, at the instance of Union Ministry of Irrigation & Power, Emergency Procedure has been laid down (vide App. II-C) in order to dispose of urgent matters expeditiously pending the meeting of the Board. Our observations on the working of the Board are as follows

- (a) it is noticed that the composition of the Board is not restricted to Ministers and officials only but some leading industrialists are also among the members. Thus, the business of the Board is conducted with the added advantage of the experience of these members in their respective fields.
- (b) The Board has been meeting practically once in every two months and some times at Koyna Project site. The Minister for P.W.D. and the Secretary, P.W.D. are Chairman and Secretary of the Control Board respectively.
- (c) Agencies for all the civil works have been fixed by now and progress is seen on all the works. Similarly, agencies for supply, inspection and erection of Mechanical and Electrical Units have also been fixed. The technical task of preparing the global tenders and specifications and administrative work in negotiating the various terms and conditions put up by contractors have been handled carefully and expeditiously.
- (d) The resolutions of the Board have been scrupulously implemented by Government of Bombay, except where approval of some other authority is required and awaited (e.g. constructing the dam to stage II dimensions).

The Team is glad to record its satisfaction that the execution of an important and complicated project like Koyna is vested with an authority of the proper type. Important items now being dealt with by the Board are :—

- (i) Determining the Tariff for Electricity to be supplied from Koyna for which a Tariff Committee has been appointed.

- (ii) Assisting the Government of India in its negotiations with the World Bank for loans to finance the construction costs of Koyna Project.
- (iii) Deciding the *modus operandi* for distribution of Koyna Power.

2.2. A Financial Adviser has been appointed to tender advice on all financial aspects of the transactions of the project. The present incumbent is a Member of the Indian Civil Service. The functions of this officer are described in App. II-D.

2.3. We feel that one of the most important reasons for the efficient manner in which this project is being executed, is that officials concerned (both Administrative and Technical) enjoy reasonably adequate powers in respect of all types of Government transactions that they have to carry out in discharge of their duties. This has the following advantages :—

- (a) Elimination of delays which cause so much frustration and further loss of efficiency.
- (b) Increasing the calibre and efficiency of the officials who have comparatively larger opportunity to use their discretion and hence develop self-confidence.

It is gathered from the record of the proceedings of the Koyna Control Board meetings that the representative of Union Ministry of Finance on the Koyna Control Board had expressed concern about larger powers enjoyed by Chief Engineers of Koyna, in comparison to other States, and suggested that the powers should be curtailed correspondingly. We feel this would be an altogether retrograde step. Restriction of powers can only result in delays and inefficiency. Alternatively if such delays are to be avoided in spite of restricted powers, recourse to irregular practices becomes inevitable. We would therefore like to propose, on the contrary, that the Centre should seriously consider why the other States also should not delegate powers comparable to these obtaining in States like Bombay and which are within the Code Rules, so that uniformly high administrative standards and efficiencies are established everywhere in the country.

2.4. *Designs Organisation*:— The Project was designed by the Engineers of Bombay State in consultation with Societe Generale Pour L-Industries, Geneva for Power House and Appurtenances. The Central Water and Power Commission serves as consultants for Dam and Appurtenances as also designs of electrical units as and when necessary. We commend this effort of the State to design the

project details and to develop designing talent. We would like to point out that projects like Koyna and Bhakra should provide personnel for building up an All India Reserve of Engineers for manning the river valley projects in other parts of the country when needed, a recommendation which we have made in our Report on Chambal Project.

2.5. The Constructional personnel on the Project is both Civil and Electrical. Civil personnel is headed by a Chief Engineer who is stationed at Project site. He is assisted by two circles under a Superintending Engineer each. There are about 13 Executive Engineers engaged in construction and designs. The electrical staff is headed by a Chief Engineer who is technically independent but is under administrative control of Civil Chief Engineer so as to ensure proper co-ordination of works which is very desirable. There are 2 circles under Chief Engineer electrical with a Superintending Engineer for each—~~one~~ for power house and another for transmission. The latter is recently sanctioned. A third circle has been proposed for designing of details. It is seen from the statement below that there exists some shortage of personnel especially in the ranks of overseers :—

Designation	Civil Strength as on 30-6-1958		Electrial Strength as on 31-3-1958	
	Sanc- tioned	Actual	Sanc- tioned	Actual
1. Chief Engineer	1	1	1	1
2. Superintending Engineers ..	2	2	2	1
3. Executive Engineers ..	13	13	9	6
4. Precision Survey Officer ..	1	—	—	—
5. Geologist	1	—	—	—
6. Research Officer	1	1	—	—
7. Rehabilitation Officer ..	1	1	—	—
8. Assistant Research Officers ..	4	4	—	—
9. Deputy Engineers	54	53	27	17
10. Overseers	242	191	85	42
11. Research Assistants	12	3	—	—
12. Laboratory Assistants ..	8	8	—	—

However, it is understood that these shortages have not been allowed to affect the progress of works materially. These sanctions are sought from the Government every year. It is to be observed that it is needless to do so, as this unnecessarily increases the work of the Control Board and Chief Engineer. The Chief Engineer may be authorised to operate upon an over-all sanction for the project period.

To give temporary non-gazetted staff a sense of greater security in service they should be given lien on similar posts in a permanent cadre. The Koyana Control Board has made a recommendation to this effect in its meeting dated 9-10-1954 but it is pending with the State Government and deserves speedy consideration as well as implementation.

Further, it is suggested that the extra permanent posts that will be required on completion of the project may be created immediately so that deserving personnel from the project organisation can be made permanent in such posts. This will give a further impetus to the efficiency of the staff.

2.6. In addition to Technical Personnel, the project provides for a number of other services as :—

- (i) Accounts organisation for internal audit.
- (ii) Rehabilitation officer of Assistant Collector's rank for rehabilitating the persons displaced from areas which are to be submerged by the lake.
- (iii) Labour Welfare Officer with an Assistant Lady Welfare Officer to look after the interests of women labourers.
- (iv) Employment Exchange.
- (v) Vigilant Squad (under an Executive Engineer).
- (vi) Medical Service.

2.7. The rehabilitation work is guided by modern and progressive ideas of compensating the displaced families by providing with land for land of equal value in lieu of cash compensations at the option of the persons displaced. Additional facilities such as employment on Project and stipends for technical training etc. are also provided to those who need them. All this constitutes work on a huge scale since nearly 80 villages are to be rehabilitated. Rehabilitation is to be done in the Districts of Kolaba, Ratnagiri and Satara, as per the choice of the displaced persons. So far two villages are completely rehabilitated and further work needs to be speeded up. A special Resettlement Committee has been appointed recently to advise the Government on rehabilitation problems. There are representatives

of the local people on this committee to contact the persons who are to be displaced and to bring their difficulties or grievances before it for early redress.

2.8. An Executive Engineer is in charge of the vigilance squad and is working directly under the Chief Engineer. • His duties are :—

- (a) Continuous checking of stores.
- (b) Surprise Checking of Muster Rolls.
- (c) Surprise Checking of attendance of subordinates.
- (d) Enquiring into all complaints against project officials.
- (e) Checking safety measures on works.
- (f) Surprise Checking of vehicles for any unauthorised transport.

The Chief Engineer agreed with the Team that checking of log-books of transport vehicles may also be handled by the unit.

2.9. The staff on this Project is working with a fine team spirit.



CHAPTER III

POWER GENERATION AND UTILIZATION

3.1. The power plant installation in the first stage consists of 4 units of 60,000 KW each. There is a provision for installing in the same power house four additional units of 60,000 KW each in the second stage. For the purpose of financial forecast it has been assumed that 39,000 KW will be transmitted to Maharashtra area by 1967-68 and rest to Bombay-Poona region.

3.2. The Koyna generating station will be inter-connected with the existing Tata-Central Railway grid and the areas to be served from this Power Pool are (A) The Bombay-Poona region (B) Koyna-Sholapur region and (C) Ahmednagar region.

3.3. The Koyna Project Report of June 1950 envisaged an installed capacity of 420 MW in the 1st stage and 660 MW in the 2nd stage, and a system demand of about 380 MW in 1956-57 rising to about 670 MW in 1965-66. This included lift-irrigation loads in Bijapur District and special industrial loads in the Koyna-Sholapur region. The Project was substantially modified in 1952 limiting the power generation to 240 MW in the 1st stage. The load envisaged was 382 MW in 1958 rising to about 467 MW by 1966. In the Project Report of 1956, a demand of 404 MW was expected in 1958 rising to 630 MW in 1966.

3.4. Estimates made by the World Bank Team, the Bombay Electricity Board and the C.W. & P.C. however, indicate a more rapid growth than what has been envisaged in all the above projects. These figures are given below :—

Years		C.W. & P.C. (1957) (M.W.)	Bombay Electricity Board(1957) (M.W.)	Koyna Project Report (1956) (MW)	World Bank's Team 1957 (MW)	I&P Team 1958 (M.W.)
1958	—	432	405	404	405	378
1959	—	466	465	439	465	408
1960	—	510	520	470	520	440
1961	—	586	562	505	565	470
1962	—		617	540	590	510
1963	—		656	563	645	550
1964	—		695	588	680	595
1965	—		733	609	715	680
1966	—	927	769	631	750	727
1967	—		809	652	785	—
1968	—		848	674	815	—
1969	—		883	—	850	—
1970	—		919	—	890	—
1971	—	1346	955	—	—	—

3.5. The load forecasts have been examined by the Team recently and discussions were held also with the Tatas and the Koyna Project officials. The present position about the growth of load is indicated below:—

A. Bombay-Poona Region—A recent estimate for the load growth in this region has been prepared by Tatas based on additional load definitely expected upto 1965-66 from existing consumers and from new consumers. The present system demand is about 390 MW and this is expected to increase to 670 by 1966. The following are the major (over 1 MW) additional industrial loads that have been taken into account :

					Load increase upto 1960	Antici- pated increase upto 1965 (M.W.).
Firestone tyre	..	..	..	..	3.1	0.2
National Rayon	..	..	..	..	4.0	16.0
Century Rayon	..	..	..	..	1.0	
Standard Vacuum	..	..	..	..	0.8	1.5
Bombay Port Trust	..	..	..	..	1.0	10.0
Mukund Iron	..	..	..	..	—	5.0
National Carbon	..	..	..	..	1.0	2.9
J. K. Chemicals	..	..	..	..	1.8	..
Ahmedabad Mfg. & Calico Mills	..	..	..	..	1.6	8.4
F. & C Osler	..	..	..	..	1.0	0.3
Indian Carbide Corporation	..	..	..	..	4.0	1.0
Fertilizers (Trombay)	..	..	..	..	—	40.0
Atomic Energy	..	..	..	..	—	17.0
Naval Dockyard	..	..	..	..	—	15.0
Tyre factory (Italian)	..	..	..	..	—	2.0
				TOTAL	19.3	119.3
Other loads below 1 M.W.	..	..	..	..	12.4	13.0

The Railway load is expected to grow as follows:—

Year	1958	1959	1960	1961	1962	1963	1964	1965
Demand (M.W.).	63	66	69	75	88	88	92	96

Taking into account the normal load growth of other licences such as B.E.S.T., Bombay Suburban etc. the load demand is expected to

increase as given in table below :—

Year			Bombay-Poona Region (M.W.)	Koyna-Sholapur Region (M.W.)	Ahmed Nagar Region (M.W.)	Total (MW.).
1958	..	..	378	—	—	378
1959	..	..	408	—	—	408
1960	..	..	440	—	—	440
1961	..	..	470	—	—	470
1962	..	..	510	—	—	510
1963	..	..	545	5*	—	550
1964	..	..	585	10	—	595
1965	..	..	630	40†	10	680
1966	..	..	670	45	12	727

*Only 10 M.W. is reserved for this region from Koyna 1st Stage. Also transmission line is not likely to be ready by 1963.

†This includes 15 M.W. load for Aluminium factory, assuming installation of Koyna 5th unit by this period.

The old thermal power plant installations at Chola with a capacity of 36 MW may have to be retired by April 1962 when they would have served for nearly 33 years. The rest of the thermal plant comprising recent installations will however have to be in service to meet the load demand. The position regarding installed and firm generating capacity would therefore be as below :—

Period	1958	1959	1960		1961		1962			1963		1964
	Jan.	Jan.	Jan.	Apr.	Jan.	Oct.	Jan.	Apr.	Oct.	Jan.	Apr.	
	Dec.	Dec.	Mar.	Dec.	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.	Dec.	
Installed	513 (a)	531 (c)	531	593 (d)	593	653 (e)	653	677 (f)	737 (h)	737	797 (i)	797
System Reserve	92 (b)	92	92	92	92	92	92	122 (g)	122	122	122	122
Firm	421	439	439	501	501	561	561	555	615	615	675	675

DETAILS

(a) Tata Hydro :— Khopoli 70 M.W. (1915) Bhivpuri 72 M.W. (1922)	(b) Trombay Chola Freg. Regn.	62 18 12	(f) + Koyna (II) —Chola (Retd.)	60 36
		92		24
Bhira 132 M.W. (1927) Rly. Thermal :— Chola 24 (1952) 54 (1954)	(c) + Chola (d) + Trombay (e) + Koyna	18 62 60	(g) + Koyna (iii) + Trombay	60 62
Trombay : 125 (56-58)			(h) + Koyna (III) (i) + Koyna (IV)	60 60
513				

B. Koyna-Sholapur Region—The load growth over and above the existing load has been estimated by the C. W. & P. C. as follows :—

Year	1955-56	1960-61	1965-66	1970-71
M.W.	10	25	72	138

These include the following industrial loads.

Small	..	..	2	4.3	6.6	9.1
Medium	..	..	0.6	1.4	2.2	3.4
Large	..	..	0.5	1.5	2.4	3.6
Heavy	..	..	2.6	12.4	53.0	113.0

The following heavy industries have been taken into account :

	1965-66	1970-71
Textiles	11.2	12.9
Chemicals	1.0	1.4
Aluminium	15.0	30.0
Engineering	4.6	6.4
Miscellaneous	1.6	2.4
Unforeseen	20.0	60.0

Excluding the 'unforeseen' heavy industry load of 20 MW, the demand in 1965-66 may be 50 MW.

The existing generating plant capacity in Utilities and Industries in the region amounts to about 26,000 KW. The load demand in 1955-56 was of the order of 16,000 KW (10,000 KW on utility stations and 6,000 KW on Industrial Stations). The major power stations in the region are the hydro-station at Radhanagari (4800 KW) and the thermal stations at Sangli (1670 KW) and Sholapur (4000 KW) amongst the Utilities. The major Industrial power stations are at Kirloskarwadi (1465 KW), Narsinghji Mfg. Co., (2300 KW) and Vishnu Textiles (1500 KW).

The transmission system to distribute Koyna power in this region is to be constructed by the Bombay State Electricity Board. However, it is understood that the scheme is not included in the 'core' of the Second Plan. If it is taken up in the beginning of the Third Plan, a part of it may be expected to be ready by 1963. Moreover

only 39 MW of power is provided in the Project. Presuming that the existing power stations in the region can meet a demand of 10-15 MW, the load demand on Koyna grid from this region may therefore be assumed to be as follows :—

Year	1963	1964	1965	1966
Demand M W	5	10	40*	45

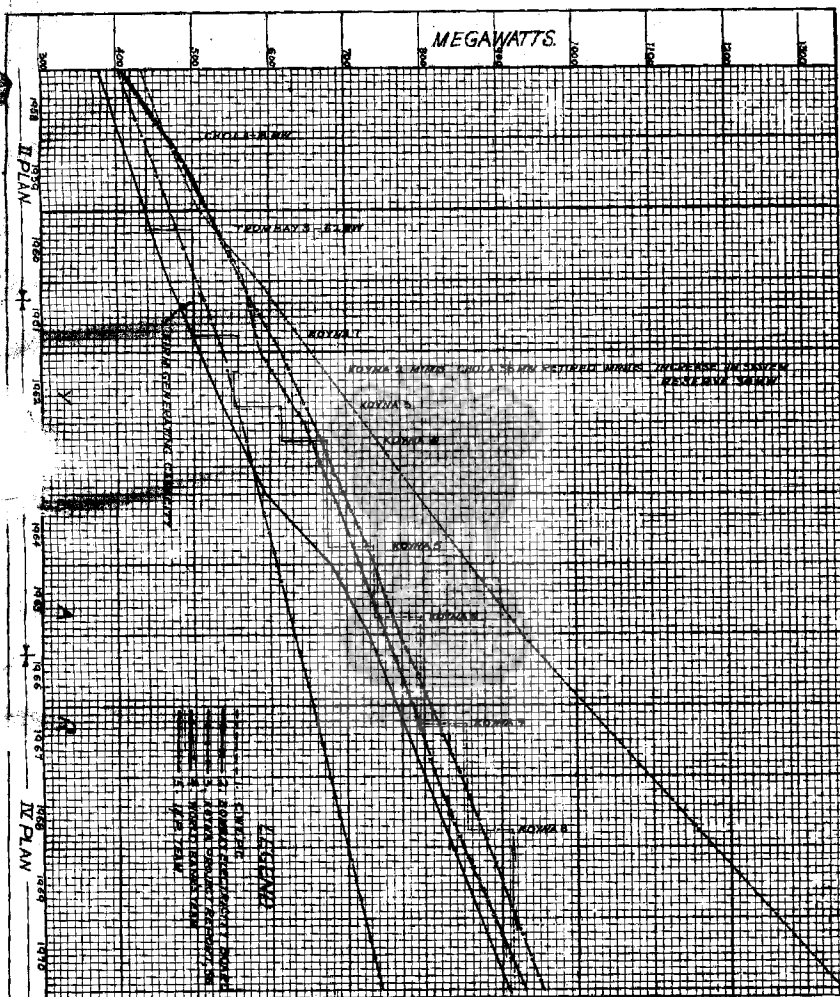
*Includes 15 MW demand for a new Aluminium factory. This would necessitate the 5th unit at Koyna to be in service by 1965.

C. Ahmednagar-Nasik Region—It is proposed to construct a transmission line from Poona to feed this region. The scheme is, however, not included in the Second Plan. The load estimate as made by the Bombay Electricity Board is given below :—

	1960-61	1965-66	1970-71
Demand M W	14	22	33

The load of this region can be catered from Koyna only in the 2nd stage *i.e.*, from 1965 onwards, when the transmission line also may be expected to be ready. Hence the demand for this region may be taken as about 10 MW in 1965 and 20 MW in 1970.

3.6. The combined load demand of the 3 regions is plotted in the Graph on the opposite page. The demands as estimated by the C. W. & P. C., the Bombay Electricity Board, and the World Bank Team are also shown in the Graph. It would be seen that the load forecast estimated by the Team is conservative when compared to those of the others; the Team, however, believes that their estimate accords with conditions governing industrial development at present. The firm generating capacity available in the grid is shown by stepped horizontal lines. It is seen that it would be necessary to commission Koyna generating Unit No. 1 by October 1961, otherwise power shortage would be felt. The other three units may follow at intervals of six months. With regard to the second stage units, the fifth unit will need to be commissioned by October 1964 and the sixth by October 1965, to avoid power shortage. Even if the load in the Maharashtra region does not develop as rapidly as anticipated it would be necessary to commission Koyna fifth unit, at the most a year later, to meet the Bombay area load. The orders for these units would therefore need to be placed not later than 1961 beginning, as it takes about



four years to commission such a unit from the date of placing orders. This question should therefore be reviewed early in 1960.

3.7. It would also be seen that the storage of water for the 2nd stage would be needed within 3 years of commissioning the 1st unit. There would not be the gap of 10 years, visualised earlier between the 1st and the 2nd stages. Hence it is necessary that the Dam should be built from the very beginning to a section required for the storage of 57,000 M.C.Ft. required for power. All the other civil engineering structures like the Head Race Tunnel, Surge Shaft, Power House excavations, Tail Race Tunnel etc. are now being built to be adequate for the 2nd stage also except for the Pressure Shafts and 2nd cable tunnel. As it takes about 2 years to construct these, it is necessary to take up the work of these elements (of the 2nd stage) in continuation of the completion of the Pressure Shafts Nos. 1 & 2.

3.8. *Power Supply Tariff*.—In the project report of 1950, the cost of Koyna power at Bombay was worked out to be 0.22 anna/unit and it was proposed to sell power to the Tatas at 0.33 anna per unit. When the project was revised in January 1952, the cost of power was estimated at 0.3 anna per unit and the selling rate at 0.35 anna per unit. In the December 1952 report, these figures were 0.376 and 0.40 anna respectively. In the latest project report of October 1956, the cost and selling rate are stated as 0.38 and 0.44 anna per unit respectively.

It would therefore be seen that the project costs have been increasing everytime the project was revised and the selling rate for electricity has been fixed only slightly above the actual costs. The rates have not been based on the consideration as to what the industries can pay for power without detriment to their production costs; neither has the question been considered, apparently, with reference to the present costs of producing thermal power in large central power stations at the load centres as at Bombay. It is felt therefore that there is a case for having a greater margin between presently estimated costs and the selling rate. The tariffs should be so framed that not only the working expenses including interest and depreciation would be recovered but there would be some surplus for reserves and contingencies.

It is recommended that the Tariff Committee that has been set up by the Koyna Control Board should give due weight to these considerations.

CHAPTER IV

INDUSTRIAL AND IRRIGATION DEVELOPMENT

4.1. The 1st stage Power of Koyna Project except about 39,000 KW to be supplied to the Maharashtra region around Karad is proposed to cater for the load demand in Bombay-Poona area. In the subsequent stages some portion is earmarked for the nearabout towns like Karad, Miraj, Sholapur, etc. It is the view of the Team that one of the main guiding principles while planning for the utilisation of power, should be to avoid concentration of industries, if the consequent social problems are to be avoided. The objective could be easily achieved only if maximum priority is attached to establishing as many industries nearabout the Koyna area as possible with a view to exploiting the natural resources such as Bauxites, available in the vicinity. Similarly, taking advantage of ample waters it should be possible to install heavy chemical industries on the tail race channel side towards the sea, specially as there is the possibility of developing a port near the Dabhol Creek. In this regard the State Government is reported to be in correspondence with the various authorities. However, the matters appear to be still in a very preliminary stage for the present and the Team has to emphasise the need for a concerted action in this direction. The benefits of developing industries near Koyna area would be as follows:—

- (a) Lower cost of production by way of reduction in transport costs of raw materials and by employment of local labour.
- (b) Reduction in costs of and losses of power in transmission
- (c) Avoiding social problems like congestion of population etc. as these industries will be located in undeveloped areas.
- (d) Plentiful soft sweet water for domestic and industrial use and for dilution of trade effluents.

Development of all these possible industries in this area implies a co-ordinated planning in both the sectors.

4.2. In view of the average continuous tail race flow which will be 1,225 cusecs in the 1st stage and 2,150 cusecs in 2nd Stage, it should be possible to develop the Dabhol Creek into a navigable channel and provide port facilities on a modest scale which would considerably

facilitate industrial development on the tail race channel. This is receiving the attention of the project authorities.

4.3. *Irrigation Development on the Tail Race Waters.* There is a flat stretch of land about $\frac{3}{4}$ mile in width, on either bank of the Vaitarni river in which the tail race channel discharges, stretching for about 6 to 7 miles, starting from about 4 miles downstream of Pophli and upto Chiplun. It would be possible to develop irrigation in this area at a very small cost by providing on either bank a small canal taking off from a pick-up weir on Vaitarni River. Even though the area which could be thus irrigated would be comparatively a small one (near about 5,000 acres), it would still be worthwhile to irrigate the same in order to meet the food and vegetable needs of the industrial population which may be expected to grow round about this area, as mentioned in para (4.1). This water could also be used for domestic supplies to the townships and villages that lie on the way. The proposal to use the tail water for the domestic purposes in Chiplun town is already under consideration.

4.4. The Government of Bombay originally intended to impound 1,56,000 M.C. Ft. of water (inclusive of carry-overs) at Koyna and utilise the same for power generation by diverting it westwards, though in the initial stages about 41,000 M.C.Ft. was to be used for lift irrigation of 4,40,000 acres in Bijapur district, which was later on to be replaced by other Krishna waters. It was, however, decided in the inter-state conference of June 1951, that only 67,500 M.C.Ft. of water should be diverted westwards for power development and the rest of the water should be reserved for developing irrigation on the eastern side of the ghats. Accordingly, Government of Bombay modified the entire Koyna Project in 1952, wherein power releases down-ghat were limited to 67,500 of M.C.Ft. Also as a result more detailed hydrological studies of the Koyna basin, it was decided to limit storage including carry-overs to 98,000 M.C.Ft. which was intended to be stored in the second stage of the project. The net storage provided for irrigation in Satara and Bijapur Districts, was 31,000 M.C.Ft. for ensuring which 10,000 M.C.Ft. of carry-over was also provided. Consequent to the States' reorganisation in November 1956, Bijapur area has been transferred to the new Mysore State which has resulted in re-thinking about irrigation Planning, so far as Bombay is concerned. The Government of Bombay have now decided reserve 16,000 M.C.Ft. of water for flow irrigation in the present Bombay State. No carry over is necessary for this limited irrigation in the State.

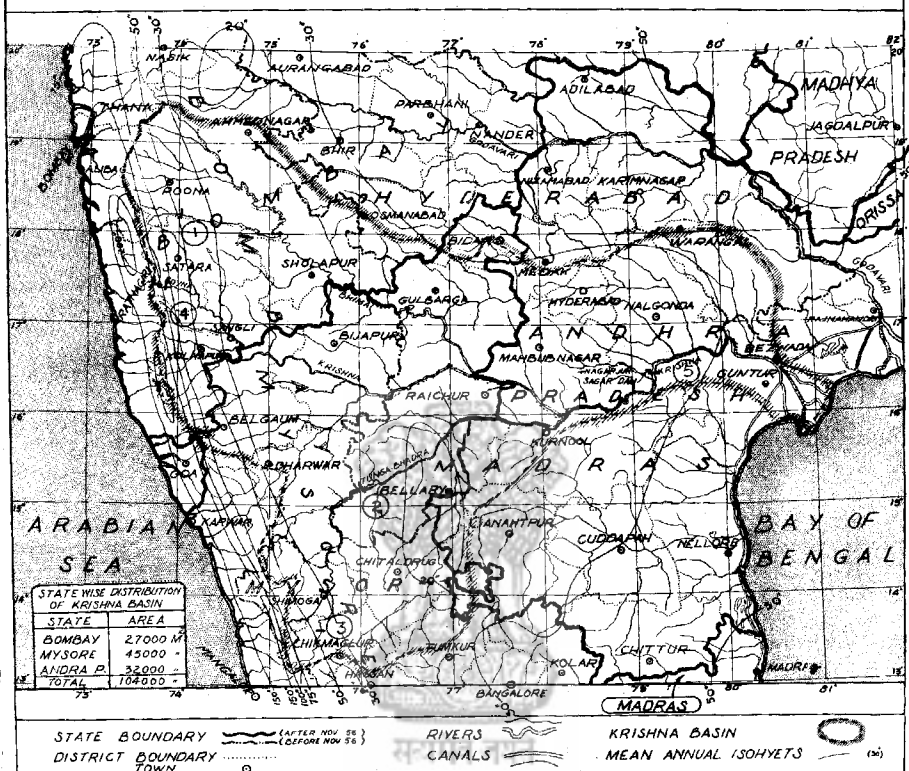
The proposal for irrigation in the Bombay State is to tap the waters from the Koyna lake through a tunnel crossing the eastern hills and then to convey the waters in a canal which would cross the river Kera and thereafter empty into the river Krishna above Kodshi (Karad Weir). This water will then be utilised in the existing Krishna Canal which will be remodelled. Also another canal on the right bank of the river Koyna-Krishna would irrigate the land in North and South Satara districts. The area expected to be irrigated is about one lakh acres. The project estimate for the irrigation scheme in Bombay State is not yet ready. The feasibility of this irrigation scheme cannot be judged at present. It is, however, very necessary that the scheme should be finalised at the earliest possible date as (a) the dam is proposed to be constructed for this extra storage of irrigation and (b) the approach to the Tunnel for irrigation needs to be completed before the same submerges in the lake.

4.5. Mysore has to decide immediately how it proposes to make use of the remaining storage of 25,000 M.C.Ft., additional foundation work for which is being done. However, recently Government of Bombay has addressed Mysore Government if they were interested in securing (on appropriate payment) further storage of 25,000 M.C.Ft. It may be emphasised that this matter needs to be settled by the two States *without* further delay as it is found that the dam section as now being constructed is for only 73,000 M.C.Ft., though the foundation excavation is being done for 98,000 M.C.Ft., in both spillway and non-spillway portions and concreting of the spillway portion is being done for 98,000 M.C.Ft. upto apron level. This question was discussed in a conference held between the Mysore and Bombay engineers on 30-7-1958 (*vide* Appendix III) but no decision has been arrived at between the two States still. It may be mentioned that the marginal cost of this storage of 25,000 M.C.Ft. would be of the order of 2.2 crores of rupees, consisting of 1.8 crores extra concreting in the dam which will be of the order of about 8 M.C.Ft. and Rs. 40 lakhs for extra land submerged. The marginal unit rate for this storage would thus be as low as about Rs. 880 per M.C.Ft. Of course, the distribution of cost between the two States will have to be based on the normal principles. It would have been proper if the question of relative shares of Bombay and Mysore in the allocations of irrigation storage was settled prior to this action by Bombay.

4.6. The inter-state conference of 1951 has laid down that the share of each of the States as existed then in the waters of the entire

MAP OF KRISHNA VALLEY

SCALE 100 50 0 50 100 MILES



- (1) Bhargav Dam on (Nira)
- (2) Tungabhadra Dam
- (3) Lakkavalli Dam (Bhadra)
- (4) Koyna Dam (Koyne)
- (5) Nagarjunasagar (Krishna)

Krishna Basin which were estimated to be 1,745 T.M.C.Ft. should be as follows:—

Allocation (T.M.C.Ft.)

					For schemes in existence and projects under con- struction.	For future develop- ment of irrigation	Total

Bombay	..	..	..	..	176·0	240·0	416·0
Hyderabad	..	..	..	..	180·0	280·0	460·0
Mysore	..	..	..	..	98·5	10·0	108·5
						(Provisional)	
Madras	..	..	..	..	275·0	470·0	745·0

As all these States have undergone major territorial readjustments during the reorganisation of the States, the present States now mainly concerned with the Krishna Waters are Bombay, Mysore and Andhra Pradesh (*vide* map of the Krishna Valley on the opposite page). The waters will have to be reallocated by the Planning Commission among these States as early as possible, to avoid complications in the preparations of new projects by the reorganised States.



सत्यमेव जयते

CHAPTER V

PHASING OF CONSTRUCTION PROGRAMME

5.1. According to December 1952 report, which was approved by the Planning Commission in 1953, on the basis of which the work was started, the first stage of the project was to be completed in six working seasons. The preliminary work on this project was started in January 1954. The December 1952, project had to be revised in view of the modifications suggested by the Swiss Consultants, and higher tendered rates quoted by the Contractors for the major items of work. The revision was done in October 1956. According to this revised estimate, the power was to be generated in October 1960.

5.2. The schedules envisaged in the October 1956 report have been further revised in March 1958 and again in July 1958, as the original schedules could not be adhered to. A comparison of all the schedules adopted since October 1956 in respect of important items of the project is given in Statement I-A & B. This reveals that the dates of starting have been postponed in the case of most of the items, by 5 to 12 months. This delay in the start of the works has been one of the causes of postponement of the date of completion. For instance, the dam concrete is now scheduled to be completed by December 1961, instead of May 1960 *i.e.*, 19 months later than originally scheduled; pressure shafts, by May 1961 instead of March 1961 *i.e.* 2 months later; and the first generating unit is scheduled to start operating from April 1961 onwards, as against July 1960. One of the reasons for postponement of these schedules is that the time taken in finalising the contracts has been more than what was originally assumed as also unforeseen difficulties like the Suez crisis etc. which hindered the starting of works. Statement II shows the time taken at various stages in the process of fixing up tenders. As the agencies for all the important works are now fixed, there should normally be no more delays beyond the tendered dates.

5.3. From Statement III showing the tempo of some important works which have been taken up by now, it is clear that in respect of the works mentioned below the present rate of progress is lower than the one required to be maintained, if the balance of work is to be completed by the revised target dates and there is a reasonable

apprehension that these works may not be completed if the tempo is not increased immediately to the necessary levels.

Name of work	Maximum Monthly tempo attained so far	Required monthly tempo to achieve targets	No. of times by which attained tempo needs to be stepped up
(i) Concreting for Dam	.. 0.2 MC ft.	1.50MC ft.	7.5
(ii) Excavation for Pressure Shafts	.. 148 feet	212 feet	1.5

Unless the tempo of work on items (i) and (ii) is increased immediately, generation of power is likely to be delayed upto July 1962 and completion of Dam concrete to May 1963 against the tender date of April 1960. The detailed position in the case of various works is as under:—

- (i) *Dam concreting.*—The two 15T cableways for dam concreting might be able to deliver upto 0.9 M.C.Ft. per month on an average as against the required 1.50 M.C.Ft., (*vide* statement I, Chapter VI). The difficulties in spreading rubble may slightly reduce this output further. This means that even when the present teething troubles are completely got over, still the delivering capacity would be only about 60 % of the requirement. Therefore it appears certain that the revised target for completing this item cannot be attained inspite of carrying out all possible improvements in the operation of the concreting equipment. We wish the construction authorities would take suitable action to increase the capacity of laying concrete by providing an additional ropeway capacity of 20 tons or any equivalent alternative device so as to be able to raise the dam to sufficient height by May 1961 to run at least one turbine by about July 1961. Assuming the proposed augmentation of the conveying capacity materialises by 1st April 1959 as explained in Appendix IV-A, it should be possible to attain the revised target.
- (ii) *Excavation for Pressure Shafts.*—There is also a danger of this work not being completed in time for generation of power in April 1961, unless special steps are taken to expedite the same as suggested in a note *vide* Appendix IV-B. The project authorities are taking necessary steps. The contractors' representatives have gone abroad to Italy and Sweden for studying the methods adopted in those

STATEMENT I-A

Comparison of Original (1956 October Report) and Revised (March & July '58) schedules of construction.

Serial No.	Name of work	Starting of Works			Completion of works					
		Scheduled Date of start		Postponement in start (5)	Scheduled date of completion					
		Original (3)	Revised April '58 (4)		Original (6)	Revised April '58 (7)	Revised July '58 (8)	Postponement in completion (9)		
(1)	(2)									
<i>Dam and Appurtenances :</i>										
1.	Excavation in over burden	Oct. '55	Oct. '56	12 months	May '57	Jan. '60	—	—	32 months	
2.	Excavation in Rock	.. Oct. '55	Oct. '56	12 months	May '58	May '59	—	—	12 months	
3.	Concreting	.. March '57	March '58	12 months	May '60	Dec. '61	—	—	19 months	
4.	Sluices & Penstocks	.. Oct. '59	Oct. '58	12 months earlier	May '60	May '59	—	—	12 months earlier	
5.	Spillway Gates	.. Oct. '60	Jan. '62	15 months	March '61	May '62	—	—	14 months	
<i>Underground Excavation :</i>										
6.	Head Race Tunnel	.. Jan. '56	Nov. '56	10 months	Dec. '57	Oct. '58	Oct. '58	Oct. '58	10 months	
7.	Surge chambers	.. Nov. '56	Feb. '57	3 months	May '58	May '58	Oct. '58	Oct. '58	5 months	
8.	Pressure shafts	.. Nov. '56	Nov. '57	12 months	April '59	Dec. '58	March '59-I Nov. '59-II	March '59-I Nov. '59-II	7 months	
9.	Emergency Valve Tunnel	Feb. '57	Oct. '57	8 months	August '57	June '58	Nov. '58	Nov. '58	15 months	
10.	Machine Hall	.. Aug. '56	April '57	8 months	Jan. '59	Jan. '59	Nov. '59	Nov. '59	10 months	

11.	Transformer Hall	..	May '57	Oct. '57	5 months	March '59	Jan. '59	Nov. '59	8 months
12.	Cable Tunnels	..	Oct. '58	Oct. '57	12 months earlier	May '59	May '59	Nov. '59	6 months
13.	Approach Tunnel	..	Jan. '56	—	—	Dec. '56	—	—	—
14.	Ventilation Tunnel	..	Jan. '56	—	—	May '56	—	—	—
15.	Tale Race Tunnel	..	March '56	March '56	—	Aug. '58	March '59	Jan. '59	5 months
<i>Concrete lining for :</i>									
16.	Head Race Tunnel	..	Dec. '57	Jan. '59	13 months	March '60	Dec. '59	March '60	—
17.	Surge	..	Dec. '58	Dec. '58	—	May '59	May '59	March '60	10 months
18.	Pressure shafts	..	Oct. '58	Jan. '59	3 months	March '61	Dec. '59 Dec. '60	Oct. '60-I May '61-II	2 months
19.	Emergency Valve Tunnel	..	April '57	Feb. '58	10 months	May '57	Dec. '58	April '60	35 months
20.	Machine Hall	..	Jan. '57	Nov. '57	10 months	May '60	March '61	April '62	23 months
21.	Transformer Hall	..	Oct. '57	March '58	5 months	May '59	May '59	—	—
22.	Tail Race Tunnel	..	Oct. '58	April '58	6 months	April '60	Feb. '60	March '60	1 month earlier 3 months earlier.
23.	Installation of Gates etc.	..	Oct. '59	Oct. '59	—	April '60	Jan. '60	—	—

STATEMENT I-B

Showing comparison of original and revised schedules of ordering and completion of erecting electrical and mechanical items

S. No.	Item of work	Date of ordering			Date of completion		
		Original (3)	Revised (4)	Postponement in months (5)	Original (6)	Revised April '58 (7)	Postponement in months (9)
1.	Jetty Crane	Aug. '56	Sept. '56	1 month	Sept. '58	March '59	Jan. '59
2.	Generation Stn. Crane ..	Dec. '56	May '57	6 months	Dec. '58	Feb. '60	June '59
3.	Generating units :						
I	.. ..	} Sept. '56				March '61	March '61
II	.. ..					Aug. '61	March '61
III	.. ..			1 month	July '61	Jan. '62	Sept. '61
IV	.. ..				Jan. '62	June '62	March '62
4.	Indoor Switchgear and control cables (gen. stn.)	Nov. '57	July '58	8 months	Jan. '62	Dec. '61	—
5.	Transformers (gen. stn.) ..	Oct. '56	Oct. '56	No delay	"	June '62	March '62
6.	230 KV cables	Dec. '57	Nov. '58	11 months	"	April '62	March '62
7.	E.H.T. Switchgear gen. stn.	Feb. '57	Aug. '57	6 months	"	March '62	March '62
8.	Workshop	Dec. '56	May '58	18 months	July '60	Oct. '59	June '59
9.	220 KV transmission line	Oct. '56	Nov. '56	1 month	May '60	March '61	March '61

10.	E.H.T. Switchgear (Rec. stn.)	Feb. '57	Dec. '57	10 months	July '60	March '61	March '61	8 months
11.	Synchronous condensers							
I	.. .. .	..	Dec. '56	1 month	July '60	—	March '61	8 months
II	.. .. .	..	June '58	7 months	Nov. '60	March '61	March '61	4 months
12.	Indoor Switchgear (Rec. stn.)	Dec. '57	Jan. '58	13 months	July '60	Dec. '61	March '61	8 months
13.	Receiving Stn. Crane	Dec. '56	Jan. '58		Aug. '59	May '60	April '60	8 months
14.	Transformers (Rec. Stn.)							
I	.. .. .	..	Oct. '56	No delay	June '60	—	March '61	9 months
II	.. .. .	..	Oct. '56		Jan. '61	July '61	Oct. '61	9 months

STATEMENT II

Showing time taken for calling and accepting tenders

S. No.	Name of work (2)	Amount of contract in Rs. lakhs (3)	Date of calling for tenders (4)	Date of opening of tenders (5)	Date of approval of tender (6)	Time taken from					
						Calling to opening (7)	D	M	D	Opening to approval (9)	Calling to approval (10) (11) (12)
1.	Constructing a rubble concrete dam on the river Konya ..	788.94	28th & 30 th May 1955.	10-1-56	15th March 1956	7	10	2	5	9	15
2.	Approach and Ventilation Tunnel	31.44	11th & 14th May 1955.	15th Dec. 1955	15th March 1956	7	0	3	0	10	0
3.	Intake to Emergency Valve Tunnel.	257.36	11th & 14th May 1955.	15th Dec. 1955	15th March 1956	7	0	3	0	10	0
4.A.	Pressure shafts, Power House and Appurtenances ..	275.00	15th & 19th June 1956.	25th Oct. 1956.	28th Jan. 1957	4	5	3	3	7	8
B.	Providing steel lining ..	..	..	15th Oct. 1957	June '58	—	—	8	15	—	—
5.	Jetty crane ..	5.05 (C. I. F. + erection)	12-1-56	1-6-56	22-8-56	4	20	2	21	7	11
6.	Turbines ..	69.79 (C. I. F. + erection).	7-8-55	2-4-56	18-9-56	7	25	5	16	13	11
7.	Generators ..	73.88 (C. I. F. + erection).	7-8-55	2-4-56	22-8-56	7	25	4	20	12	15

8. Transformers Gen. Sin. ..	34-88 (C. I. F. + erection).	23-11-55	15-5-56	22-8-56	5 22	3 7	8 29
9. Power House Cranes ..	11-12 (F.O.R. Bombay erection).	1st week of Oct. 1956.	27-12-56	9-3-57	2 20	2 12	5 2
10. Towers and accessories Insulators and Accessories and erection. (220 KV Transmission Lines).	95-00	22-11-55	25-4-56	21-9-56	5 3	4 26	9 29
11. Power, Conductor and Accessories (220 KV Transmission Lines).	104-74 (F. O. R. Kundara).	22-11-55	25-4-56	22-8-56	5 3	3 27	9 0
12. Ground cable. (220 KV Transmission lines).	3-18 (F. O. R. Bombay).	22-11-55	25-4-56	22-8-56	5 3	3 27	9 0
13. 125 MVA-Auto Transformers (Receiving Station)	29-52 (C. I. F. Bombay).	23-11-55	15-5-56	22-8-56	5 23	3 7	9 0
14. Synchronous condensers, (Receiving Station).	17-65 (C. I. F. Bombay).	5-4-56	31-8-56	23-11-56	4 26	2 23	7 19
15. Development of Receiving Station site, (Receiving Station).	1-66	22nd 24-9-56.	29-10-56	27-12-56	1 6	1 29	3 5
16. First Erected 3 sets 1150 KV Capacity (including switch-gear) (Diesel Generating sets).	15-50 at site and sec- tion).	18-4-55	17-5-55	28-9-55	1 ..	4 11	5 11
17. Newly ordered sets 1012 KW capacity (including Switch-gear) (Diesel Gen. Sets).	10-90 (at site erection).	3-1-57	18-1-57	6-2-57	0 15	0 18	1 3
18. Substation equipment ..	1-38	5-5-55	16-6-55	20-8-55	1 11	1 4	2 15
19. Transformers ..	2-63 (F.O.R. Karad).	24-12-54	22-1-55	16-5-55	0 28	3 24	4 22

STATEMENT III

Tempo of civil works in progress

S. No.	Name of work	Tempo of Work				Up-to-date quantity	Total quantity	Balance on 1-6-58	Target date of completion (Rev. July '58)	No. of working months available after 31-5-58	Average monthly tempo required to complete the work in time
		Feb. '58	March '58	April '58	May '58						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>Dam and Appurtenances :</i>											
1.	Concreting ..	—	0.12	0.20	0.13	0.45	36.4	35.95	May '61*	24	1.50 M.C.Ft.
<i>Underground Excavation :</i>											
2.	Head Race Tunnel ..	715'	874'	820'	818'	9,048	12,300	3,252	Oct. '58	5	650'
3.	Surge chambers ..	10'	10'	24'	27'	92'	320'	228	Nov. '58	6	38'
4.	Pressure shafts ..	—	7'	75'	148'	230'	4,040'	3,810'	Nov. '59	18	212'
5.	Power House ..	0.26"	0.27	0.32	0.19	1.78	6.98	5.20	Nov. '59	18	0.29 M.C.Ft.
6.	Tale Race Tunnel ..	311'	272'	259'	281'	5810'	7,500'	1,690'	Dec. '58	7	242'

*By these dates, practically the bulk of the work is scheduled to be completed.

countries for speedier excavation of the Pressure Shafts. They are also going to obtain Swiss personnel for fabricating and installing the steel pipes to obtain the required progress for completion of the work by target date (vide appendix IV-B). The project authorities have standing arrangements with their consultants for obtaining advice and assistance of experts in this line when necessary. This may be availed of, if any difficulty is experienced.

- (iii) *Thana Creek Crossing*.—The designs of the Thana-Creek crossing have just been finalised but the agencies of construction need to be fixed up early, otherwise this may prove to be a bottleneck.

5.4. The present progress report does not seem to include bar-charts for programmes and progress as prescribed in the Report of Rates and Costs Committee. It is highly desirable to prepare such charts for monthly progress.

5.5. The October 1956 project provides for the construction of the dam for F.R.L. 2088.0 to store 36,000 M.C.Ft. of water for generation of 240 MW at 60% load factor in the first stage. After full consideration of the various factors involved in the two stage construction, the project authorities provided for in their estimate a spillway of full width both in foundation and superstructure required for the final stage to store 98,700 M.C.Ft. with F.R.L. of 2,158.5. As far as the non-overflow section is concerned, it was considered that truncation in both width and height would be justified only if the time lag between the two stages was of the order of about ten years, which would enable the first stage construction to reach equilibrium before widening for the 2nd stage. As the load development was not expected to be as rapid as is expected at present, the full width required for the final stage was provided in the non-overflow portion upto ground level only. The width for superstructure portion was provided only for the first stage of 36,000 M.C.Ft. The total quantity of concrete provided in this estimate was 36.4 M.C.Ft.

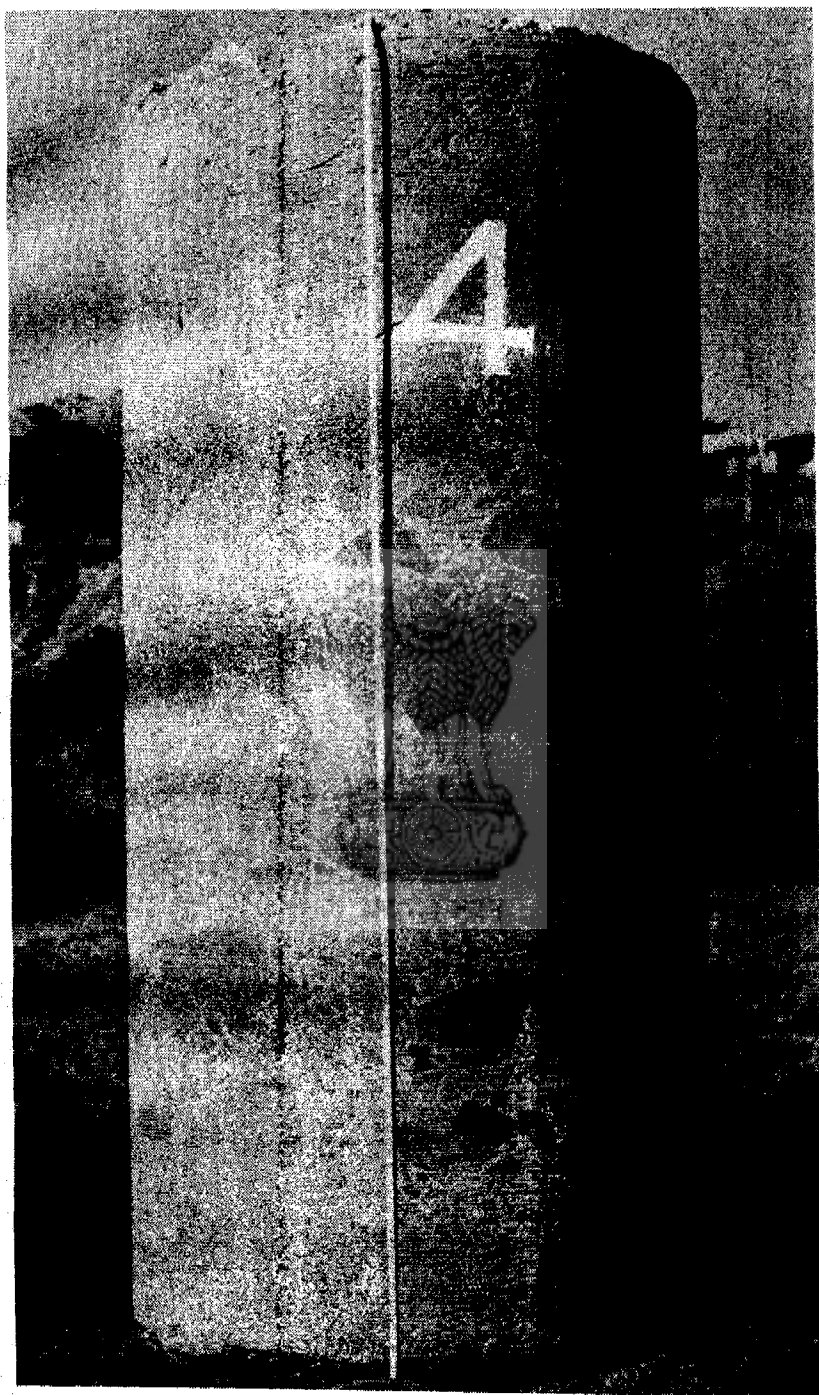
5.6. According to the latest conservative forecasts of load development, as discussed in Chapter III, it will be seen that there will be power shortage from 1965 onwards, unless power from II stage is available by that time. The required time-lag for obtaining equilibrium, before second stage is started, will therefore not be available. It would therefore seem to be desirable to merge the 2nd stage construction with the first stage, so far as the storage for power is concerned and to rephase the details of construction work, so as to attain the the targets of power demand, as discussed in Chapter III and also

as already proposed by Shri S.L. Kirloskar, a member of the Koyna Control Board and supported by Chief Engineer, Koyna (*vide* appendix V). The Koyna Control Board has already approved the construction of the dam to the width required for storage of 73,000 M.C.Ft. upto the crest level of the 1st stage. This stage includes 57,000 M.C.Ft. for power and 16,000 M.C.Ft. for irrigation in North and South Satara districts of Bombay State. In order to carry out this proposal the sanctioned constructional features of the dam have been modified. The present programme is to construct the foundation of the spillway to the full width, but the superstructure section has been modified and is proposed to be constructed for a storage of 73,000 M.C.Ft. only and not for 98,000 M.C.Ft. as provided in the October 1956 estimate. This of course reduces the concrete in this section. Similarly the foundation concrete of the non-spillway portion above the keying level upto ground into the rock has also been reduced to suit a storage of 73,000 M.C.Ft. only. The superstructure portion in the non-spillway portion is proposed to be constructed for 73,000 M.C.Ft. against that for 36,000 M.C.Ft. provided in the estimate, thereby increasing the quantity of concrete. The total quantity of concrete in these proposals comes to 36.4 M.C.Ft. which is the same as provided in the 1956 estimate. Thus excesses have balanced the savings. By making these changes, specially in the spillway portion, the construction work for the ultimate storage of 98,000 M. C.Ft. will become difficult and more costly.

5.7. For facility of construction programme of later stages, it would be desirable to construct the dam in 1st stage both in spillway and non-spillway portion to the full width both in foundation and superstructure for the final stage of 98,000 M.C.Ft., but upto the crest level of first stage to store 36,000 M.C.Ft. The total quantity of concrete in this programme will be 41.5 M.C.Ft., against 36.4 M.C.Ft. provided in 1956 estimate. This will involve an extra expenditure of about Rs. 1 crore. If this work is postponed to the 2nd stage, it will not only be difficult but will cost very much more. For raising the dam to a height required for working one turbine by the target date, it would involve laying an additional quantity of 3.7 M.C.Ft. of concrete. All other plant excepting the concrete laying machinery is adequate for this purpose.

Typical sections of both the spillway and non-spillway portions of the dam for the above three alternatives are shown on the opposite page.

5.8. The difference in the cost of constructing the dam to store 98,000 M.C.Ft. and that for 73,000 M.C.Ft. will only be about



6' x 3' DIAMETER CORE OF RUBBLE CONCRETE

Rs. 2.2 crores. This is amply justified by the several benefits indicated below:—

- (i) Raising the reservoir level from F.R.L. 2,136 to F.R.L. 2158.5 will raise the mean operating head on the Koyna Power House by 37.8 ft. With the same water diversion *i.e.* 67,500 M.C.Ft. this will enable an additional generation of 50.7 MKW hrs. at the main power station annually. The additional energy can also be sold to the prospective bulk power consumers with no additional cost than that necessary for meeting the fixed and running charges of the extra cost of raising the Dam. Assuming 10% losses in transmission and an average bulk sale rate of 0.40 anna per KW hr. (it will probably be substantially more than this), the additional annual revenue will be Rs. 11.4 lakhs as worked out in the statements IV & V. This alone will cover the interest and working expense on this additional capital cost.
- (ii) The additional energy generation (50.7 MKW hrs.) being firm, it will help to increase the saleable peak capacity of Koyna at 60% load factor. In terms of peak load at Koyna Power Station, raising of the dam to full height will enable Koyna to carry an additional peak load of 9,650 KW firmly at 60% L.F. As the total increased peaking capacity *i.e.* 408 MW at 60% L.F. is still less than the firm plant capacity (420 MW) or installed capacity (480 MW) of the Koyna Power Station, no additional costs would be incurred for generation or transmission plant to sell this amount of additional peak load at 60% L.F. On the other hand, as the quantity of water that can be diverted to the west is limited, economical hydro energy generation of 50.7 MKW hrs. annually would continue to remain undeveloped if the Dam is built for 73,000 M.C.Ft. (upto F.R.L. 2,136 ft.). In the integrated Bombay-Koyna Power System, the corresponding amount of energy would be generated thermally. At prices of coal or oil that will prevail when Koyna operates at full capacity, fuel costs only for thermal generation will be 0.4 anna or more per KW hr. Hydro generation will therefore be less expensive and will conserve fuel.
- (iii) The additional storage capacity of 25,000 M.C.Ft. would be obtained at an estimated additional cost of Rs. 2.2 crores. This will amount to Rs. 880 per M.C.Ft. This

is a very economical cost for storage of this magnitude. Supplies from this storage may be utilised profitably for irrigation purposes in the Mysore State.

- (iv) Provision is made in the present designs of the Dam for building a power station at the foot of the Dam in III stage and generating power by utilising the monsoon discharges from the reservoir into the Koyna River. Full details have not yet been worked out; provision is being made for installing two 96" diameter penstocks in the Dam; plant capacity is stated to be 30 MW. Power from this station would be seasonal. The economics of seasonal power generation in this manner has to be examined in detail. In the Bombay-Koyna integrated system, where there is a considerable thermal generation of power, such hydro generation would be profitable if the energy can be sold at incremental fuel cost of thermal generation i.e., at about 0.4 anna per KW hr. or less as referred to in (ii). Storing 25,000 M.C.Ft. in the reservoir and letting it down in the dry months, will improve the economics of power generation at this station. Maximum annual generation of 129.6 MKW hrs. is possible at the Dam power station if the station plant is designed to utilise 25,000 M.C.Ft. in regulated discharges.

5.9 It appears now that it would be difficult to change the present programme of construction. When the tenders for the dam were invited the quantity of concrete shown was only 31 M.C.Ft. The reduction in the quantity of concrete was due to the section in the non-spillway portion being reduced from that provided for full storage to that necessary for first stage storage of 36,000 M.C.Ft. The concrete work was to be finished by 30th April 1960 and power was to be generated in October 1960. The concrete work has already increased to 36.4 M.C.Ft. due to change in construction programme as explained in para 5.6. This quantity cannot be finished in time without increasing the capacity of equipment for laying concrete. There will be a further increase of 5.1 M.C.Ft. of concrete if the dam is to be built for 98,000 M.C.Ft. section upto 36,000 M.C.Ft. storage level, of which 3.7 M.C.Ft. will be below R.L. 2,030', the level required for storage to run one machine. If this quantity of 3.7 M.C.Ft. is to be done in the same time, there will be further difficulties. On account of the various factors the generation of power has already been deferred from October 1960 to July 1961. It is considered that any further postponement in generation of power will have serious dislocating consequences in the industrial activities

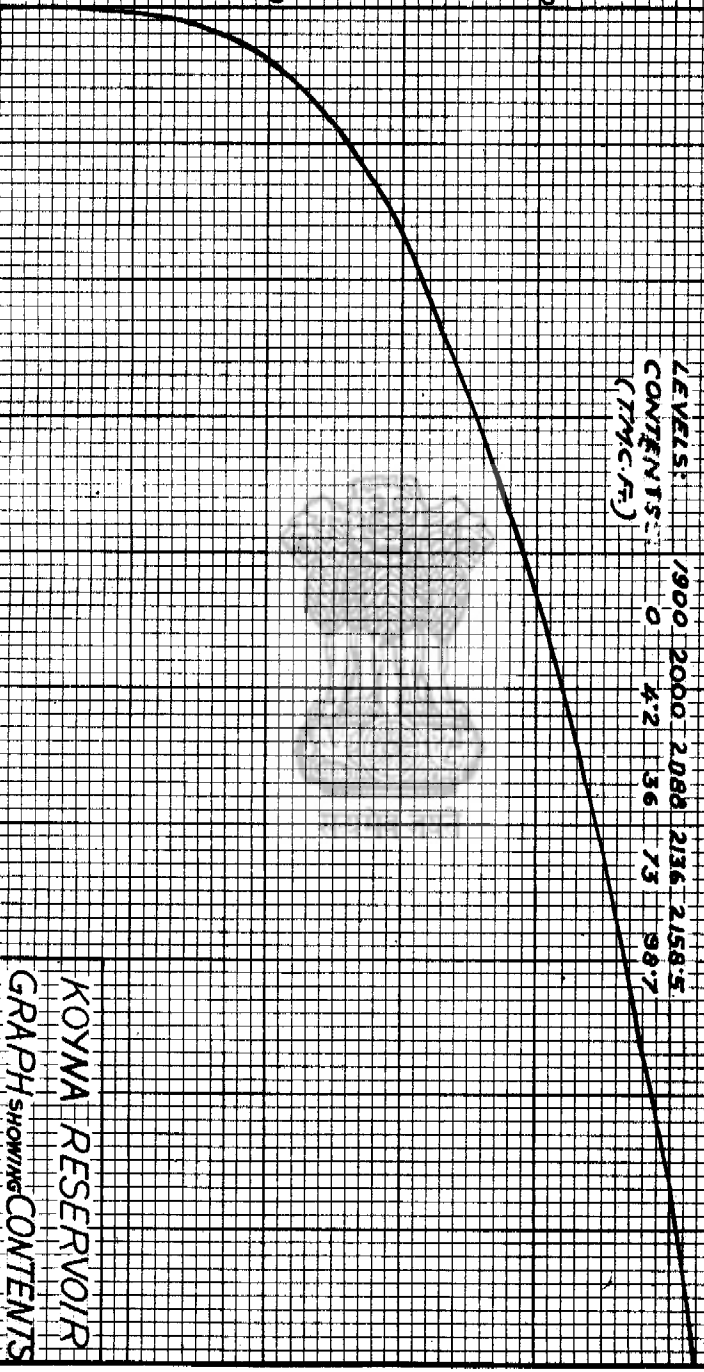
RESERVOIR LEVELS (K.R.Ls)

NOTE: THE GRAPH IS PREPARED BY I.R.D. TEAM FROM RESERVOIR LEVELS & CONTENTS AS BELOW:-

LEVELS:	1900	2000	2080	2136	2158.5
CONTENTS:-	0	4.2	36	73	98.7
(T.M.C.F.T.)					

KOYNA RESERVOIR
GRAPH SHOWING CONTENTS

C 10 20 30 40 50 60 70 80 90 100
O N T E N T S
T.M.C.F.T.



STATEMENT IV

Showing extra head available for power generation on constructing the dam to 98.7 T.M.C. Ft. capacity.

Monthly depletion for reservoir operation I* (with irrigation below dam) $\frac{67.5}{12} + \frac{41}{8} = 5.625 + 5.125 = 10.75$ T.M.C.Ft.

Monthly depletion for reservoir operation I-A* & II* (i.e. without irrigation below dam) $= \frac{1}{12} (67.5) + \frac{1}{8} (41) = 5.625 + 5.125 = 10.75$ T.M.C.Ft.

Date	I : 98.7 T. M. C. Ft. total and 4 T. M. C. Ft. Dead			I-A : 98.7 T.M.C. Ft. total and 29 T. M. C. Ft. Dead			II : 73 T. M. C. Ft. total and 4 T. M. C. Ft. Dead		
	Reservoir contents (T.M.C.Ft.)	Levels (3)		Reservoir contents (T.M.C.Ft.)	Levels (4)		Reservoir contents (T.M.C.Ft.)	Levels (5)	
(1)	(2)	(3)		(4)	(5)		(6)	(7)	
1st Oct.	98.70	2158.5		98.700	2158.5		73.000	2136	
1st Nov.	87.95	2150.0		91.075	2153.0		65.375	2127	
1st Dec.	77.20	2140.0		83.450	2146.0		57.570	2118	
1st Jan.	66.45	2128.0		75.825	2130.0		50.125	2110	
1st Feb.	55.70	2116.0		68.200	2131.0		42.500	2100	
1st March	44.95	2103.0		60.575	2122.0		34.875	2086	
1st April	34.20	2086.0		52.950	2113.0		27.250	2072	
1st May	23.45	2064.0		45.325	2103.0		19.625	2055	
1st June	12.70	2036.0		37.700	2091.0		12.000	2035	
1st July	4.00	2000.0		30.075	2080.0		4.375	2000	
1st August	54.00	2114.0		85.000	2147.0		54.000	2114	
1st Sept.	98.70	2155.5		98.700	2158.5		73.000	2136	
Mean Reservoir Levels :		2104.2			2128.5			2090.7	
Less Mean Reservoir level for II :		-2090.7			-2090.7				
Extra head gained over II :		13.5			37.8				

* Reservoir Operation I represents 98,700 M.C.Ft. reservoir, releasing the 25,000 M.C.Ft. of surpluses down the dam in a regulated way during fair weather.

Reservoir Operation I-A represents 98,700 M.C.Ft. reservoir, keeping the 25,000 M.C.Ft. of surpluses as additional dead storage.

Reservoir Operation II represents 73,000 M.C.Ft. reservoir, without any irrigation surpluses to be let down the dam.

STATEMENT V

Showing additional power generated and increase in revenue therefrom from a 98,700 M.C.Ft. reservoir as compared to 73,000 M.C.Ft. Reservoir

- (i) Approximate average head on dam power house,
(with effective tail race level about 1930')
 $= 2104.2 - 1930 = 174.2 \text{ (ft.)}$
- (ii) Power releases down the main (western) Power House $= \frac{67,500 \times 106}{365 \times 24 \times 3600} = 2144 \text{ cusecs}$
- (iii) Irrigation releases down the dam power house
(for reservoir operation conditions I) $= \frac{25,000 \times 106}{243 \times 24 \times 3600} = 1190 \text{ cusecs}$

Reservoir operation I : 98700 to 4000 M.C.Ft.										Reservoir operation I-A 98700 to 29000 M.C.Ft.				
Power House	Average Discharge (cusecs)	Power generated		Gain in head (ft.)	Annual energy generated (M.K.W. Hrs.)	Net-Sale-able units (90% of gross) MKWHrs.	Annual revenue at 0.4 anna per unit (Rs. lakhs)	Power generated		Annual energy generated		Annual revenue at 0.4 anna per unit Rs. lakhs		
		Average K.W.	Peak K.W.					Average K.W.	Peak K.W.	Gross Units Mills	Net (at 90% of gross Mil. Units.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	
Main (Western)	2144	13.5'	2,070	3,450	18.1	16.3	4.1	37.8	5,790	9,650	50.7	45.6	11.4	
Dam (Toe)	1190	174.2'	14,810	24,680	129.6	116.6	29.1	—	—	—	—	—	—	
TOTAL	..		16,880	28,130	147.7	132.9	33.2	37.8	5,790	9,650	50.7	45.6	11.4	

in Bombay region. It is understood that the increase in quantity of concrete to be finished by May 1961 is likely to lead to complications with the contractors in respect of rates and completion programme (*vide* appendix X).

5.10 The Mysore Government have recently communicated to the Bombay Government stating that the storage in Koyna need not be increased on their account but that it should be so fixed that it will be possible for Mysore to utilise its share of the Koyna water in Mysore territory. The Team has already expressed the urgent necessity of re-allocation of Krishna water to the various States concerned in Chapter IV.

5.11. The present programme of construction provides for a section adequate for storage of 73,000 M.C.Ft. of which 57,000 M.C.Ft. is for development of power and 16,000 M.C.Ft. for irrigation in Bombay State. The full development of the power will take place by 1970. Similarly the construction of irrigation system and development of the same will take some years. It would, therefore, be possible to let down reasonable quantum of water for irrigation both in Bombay and Mysore States for some years after completion of the dam for a storage of 73,000 M.C.Ft. When Mysore State decides to share the Koyna storage waters, or when extra firm power is required, further programme of thickening the dam can be considered.

5.12. It is however considered that there will be great difficulty in thickening the superstructure of the spillway portion later on. Apart from constructional difficulties there will be very limited time during working season to do this work. The total extra quantity of concrete involved in this work is 0.88 M.C.Ft. upto crest level for 36,000 M. C.Ft. of storage, of which only 0.55 M. C.Ft. will have to be done before May 1961. This will mean an increase of about 2% in the quantity of concrete or about a fortnight's work for the concrete laying equipment. This work is already provided for in the October 1956 estimate. The Team would, therefore, advise that the spillway superstructure should be constructed to full width required for the final storage of 98,000 M.C.Ft.

5.13. In view of these circumstances the present programme of construction of the dam upto the crest level of the 1st stage may be adhered to except for the small modification suggested in para above for the spillway superstructure section, but all efforts should be made to see that the dam is raised to a sufficient height by May 1961 to run at least one turbine by about July 1961.

Further construction to store 57,000 M.C.Ft. of water for power should be done in a continuous operation with the 1st stage.

Rest of the programme should be co-ordinated with irrigation schemes of the Koyna both in Bombay and Mysore.

5.14. In view of the necessity to develop the 2nd stage power by 1965, the 3rd and 4th pressure shafts and second power cable tunnel will also have to be completed by that time. This work might be done departmentally as rock excavation work at present being done by the department in the Tail Race Tunnel is much cheaper than similar work being done through contractors. It would be desirable to start this work by 1959-60 so that sufficient time is available for completion of the same by 1964. The Chief Engineer, Koyna is keen to take up this work departmentally immediately after he finishes the tail race tunnel in 1959 and in our opinion that would be quite suitable as it would combine the organisational interests with the requirements of the project. The additional outlay on this account during the Second Five Year Plan would be on the excavation only and it would not exceed Rs. 18 lakhs.



CHAPTER VI

FEATURES OF DESIGN AND CONSTRUCTION

6.1. So far as designing of Power Projects in India is concerned the Koyna Hydro-Electric Project is unique mainly in two respects :—

- (a) The water is diverted to the western sea for utilising the potential head available, whereas the river itself flows to the eastern sea.
- (b) Apart from the dam, the project consists of mostly underground structures such as Head Race Tunnel, Surge, Pressure Shafts and Power House with all the necessary tunnels for approach, cables, ventilation and tail race, all of which are excavated in Basaltic rocks.

6.2. During the initial stages, the design organisation consisted of one Superintending Engineer, assisted by 4 Executive Engineers, one of whom was on the field, 6 Deputy Engineers (Assistant Engineers) and a few overseers. This being the first project of its kind in our country, the designing was by no means an easy task and it is gratifying to note that Bombay Government and their officers have tackled the problem in a satisfactory manner as described below :—

- (a) The designs for underground work and dam were done by Bombay Engineers in the first instance and those for the underground works were further subjected to scrutiny and modifications by Societe Generale Pour L-Industries, Geneva, Switzerland, a firm of specialists in Power Engineering. However, it was not considered necessary to obtain foreign consultation on the design of the dam and appurtenances, as C.W. & P.C. could help as and when necessary. A team of Engineers headed by the then Superintending Engineer, Designs was deputed for nine months to Geneva to check up the designs with the firm of consultants.
- (b) *Electrical Works* :—The organisation for electrical design initially consisted of one Superintending Engineer with three Executive Engineers who prepared all the designs for electrical works and subsequently drew up the detailed specifications also.

6.3. The Organisation during construction consists of :—

- (a) On the civil side, two Superintending Engineers and 13 Executive Engineers out of whom 4 Executive Engineers attend to working designs.

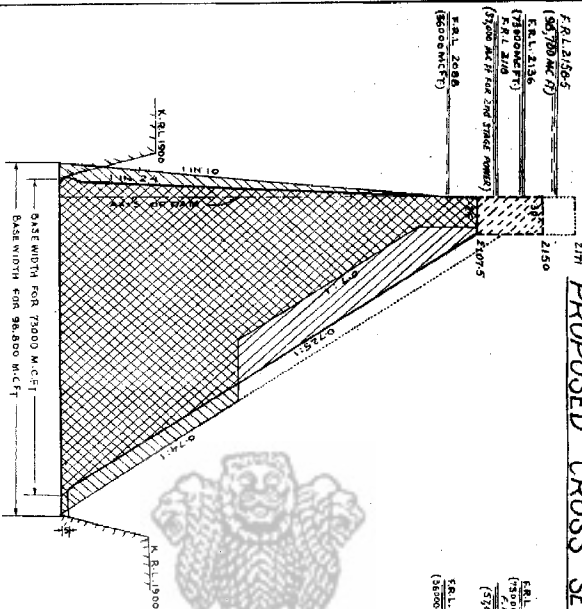
- (b) On the electrical side one Superintending Engineer is in charge of a circle. A second Circle sanctioned for Transmission Lines is recently filled up. A third circle is proposed for detailed designs of electrical units.
- (c) Quality control organisation consists of one Research Officer of an Executive Engineer's rank working under Superintending Engineer, Dam Circle assisted by 4 Assistant Research Officers and 12 Laboratory Assistants. The main work carried out by this unit is design of concrete mix, manufacture of and research regarding air-entraining agents & pozollanas and testing various samples of concrete taken at site.

6.4. The main features of design involved in the important units of the scheme are detailed below :—

Dam is a straight gravity type, to be built in rubble concrete (44% rubble placed in 56% concrete and vibrated thoroughly). This has resulted in a saving of about a crore of rupees as compared to a pure concrete dam and it yet retains all the strong points of the concrete construction. Three feet diameter cores six feet long, have been recovered through trial blocks, photograph of which appears on the opposite page. These cores proved that no cavities remained anywhere in the structure and also the permeability test cylinders drilled into the body of cores showed that the rubble concrete was in no way inferior to pure concrete. This type of concrete (i) costs about Rs. 190/- per 100 C. ft. as against Rs. 217/- the cost of pure concrete and (ii) weighs about 165 lb. per C. ft. as against 155 lbs. of ordinary concrete.

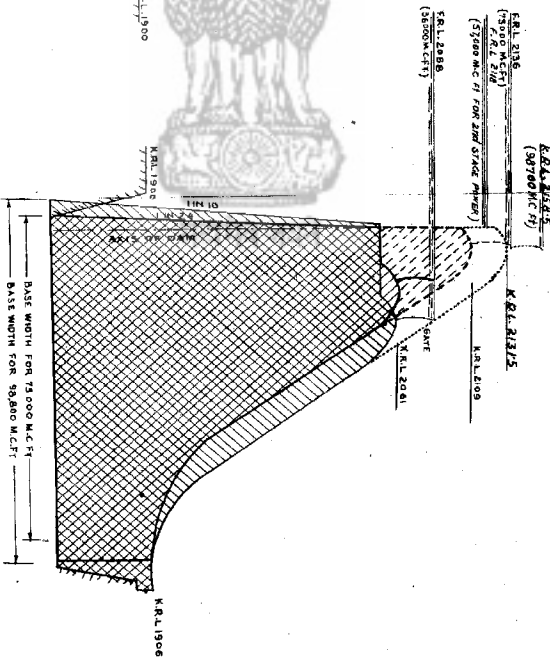
This type of construction will provide valuable data. When the technique of laying this type of concrete is successfully developed, there will be a scope of reduction in cost of dams, without in any way lowering the strength as compared to plain concrete in the case of dams where use of masonry is ruled out on structural considerations or due to non-availability of suitable stones, or skilled masons and labour in the required numbers. It may be mentioned that it has not been possible to attain the required percentages of 44 and 56 of rubble and concrete respectively. So far, various test blocks are being made varying the quantities of cement with reduced percentage of rubble,

PROPOSED CROSS SECTIONS OF KOYNA DAM



NON-OVERFLOW SECTION

SECTIONS AS PER OCTOBER, 1956, ESTIMATES
 SECTIONS FOR 73000 MC/FT UP TO STAGE I AS NOW PROPOSED
 SECTIONS TO BE ADDED ABOVE STAGE I FOR STAGE II, AS NOW PROPOSED, FOR
 73000 MC/FT.
 SECTION FOR STAGE II, AS NOW PROPOSED, FOR 98700 MC/FT



OVERFLOW SECTION

NOTE:
 THE DIMENSIONS OF THE FRONT AND REAR BATTERS ARE DUE
 TO THE REDESIGNING OF THE SECTION OF THE DAM WITH A DENSITY
 OF 145 LB/CU FT AS DETERMINED IN THE LABORATORY FOR QUADRA
 CONCRETE AS AGAINST 155 LB/CU FT ASSUMED IN THE ORIGINAL DESIGN

so as to save in cost without affecting the strength. Other features are :—

- (i) As no suitable sand is available in the vicinity, crushed rock is used for the purpose.
- (ii) Rubble and other aggregates are chilled by refrigeration so as to counter the heat of hydration.
- (iii) Two inspection galleries are provided with instruments for recording (i) Temperature (ii) Stresses (iii) Strains and (iv) Deflection. An automatic level recorder is also provided.

6.5. The cement for the Dam work is supplied in bags. If bulk supply of cement could have been arranged as envisaged in Appendix VI, it would have avoided wastage of cement in transit and handling and at the same time ensured better quality and effected saving in costs. The cement is obtained from two factories (i) Shahabad on broad gauge and (ii) Bagalkot on meter gauge. We understand that in addition to transshipment difficulties from broad gauge to meter gauge in case of Shahabad Factory and getting proper type of Railway wag-gons for carriage of cement in bulk, some of the bridges on the road from Karad to Koyna are also not strong enough to take the load of 10 to 15 ton trucks for carrying cement in bulk. Moreover, the terms of the present contracts provide for issue of cement in bags and the empty cement bags become the property of the contractors. The change-over from bags to bulk is, therefore, not considered feasible by the Project Authorities.

According to the agreements in vogue, the contractors are entitled to a rebate of Rs. 2/5/- per ton in lieu of losses of cement in transit. It is understood that these losses are actually more than what had been originally anticipated. It would, therefore, be desirable that all the necessary steps are taken to reduce these losses to the minimum.

6.6. Other features of design are :—

- (a) The Head Race Tunnel, Tail Race Tunnel and the Power House are concrete lined with steel lining at the approaches of the Head Race Tunnel.
- (b) The Pressure Shafts are inclined at 45° to the vertical and are provided with steel lining surrounded by concrete. The steel lining is designed to take half the tension, if the rock is of good quality and full tension, in the case of weaker rocks.

Ample provision for grouting is made in all the above items. The specifications for all the items of work are drawn in considerable details.

6.7. The construction features of the various units are as follows :—

- (a) The dam construction in rubble concrete is being done by means of a 200T/Hr crushing plant and a batching and mixing plant with 2 No. 3 c. yd. Mixers with third one as a stand by. The concrete from the batching plant and rubble stones are carried to monoliths of the dam by means of two, 15T cableways—one used for concrete and the other for rubble. Statement-I shows the possible average productions to be expected from these units with the proviso that the 2nd cable would also carry concrete in addition to rubble so that no capacity is idle, as is the case at present. It is seen therefrom that to achieve the production targets, it is necessary to install additional 20 ton cable-way capacity, or an equivalent device. The repercussions of the inadequate capacity of the conveying unit have also been discussed in the Chapter V on phasing of construction. Unless this drawback is rectified, it would not be possible to complete the dam within the target period. The project authorities have notified to the contractors regarding the difficult position in which they are placed for laying concrete. It is understood that the German representatives of the contractors are proceeding for consultation with their principals in Germany. If adequate progress is not shown by the contractors by December 1958, the matter would be further considered by the Project authorities (vide appendix-IV-A).
- (b) Another factor which has been tending to lower the efficiency is the long time taken to spread the rubble manually. This results in compulsory waiting of the concreting bucket and excessive cycle time. The bottleneck due to time taken in spreading rubble is proposed to be overcome by laying concrete simultaneously in two monoliths which is being considered by project authorities.

STATEMENT-I

*Delivery Capacities of the Various Construction Units of the
Koyna Dam*

S. No.	Particulars	Crushing plant	Batching & mixing plant	Conveying cable for concrete & rubble
(1)	(2)	(3)	(4)	(5)
1.	Bucket. . . . .	..	81 c. ft.	162 c. ft.
2.	No. of Buckets . . . . .	..	2 (Third one stand-by).	2
3.	Total capacity/cycle . . . . .	..	162 c. ft.	324 c. ft.
4.A	Individual cycle time . . . . .	..	2.5 mts.	6 mts.
4B.	Average cycle time (after allowing for 80% operation efficiency). . . . .	..	3 mts.	7.5 mts.
5.	Maximum hourly production.	*32,00 c. ft. Concrete.	3,240 c. ft.	2,600 c. ft.
6.	Maximum concrete production (at 22 working hours/day).	70,500 c. ft.	71,300 c. ft.	57,200 c. ft.
7.	Average Daily production (at 60% job efficiency).	42,300 c. ft.	42,800 c. ft.	34,300 c. ft.
8.	Average monthly production (at 25 working days/month).	1.06 m. cft.	1.07 m. cft.	0.875 Say 0.9 m. cft.
9.	Scheduled monthly production (on basis of 60% concrete and 40% rubble).	0.9 m. cft. (60% of 1.5 m. cft.)	0.9 m. cft.	1.50 m. cft.
10.	Per cent of capacity provided to scheduled requirements.	117%	119%	60%
11.	Deficiency			40%
12.	Size of extra plant			40X30 60

*Rated capacity of crushers.

200T/hr.

Wt. of Concrete/hr.=wt. of Rock+wt. of cement+wt. of water
 $=200+29+6=235$ Tons

Volume of concrete at 165 lb/cft. 235×2240
 $\frac{\quad}{165} = 3190$ cft.

Say $= 3200$ cft

6.8. One of the difficulties experienced hitherto was in regard to procurement of steel. It is understood that necessary import of the same has now been sanctioned. It appears that there are several delays in procuring the actual import licenses. In some cases the goods have arrived and have been lying in docks for over three months and cannot be cleared for want of licenses. These delays need to be minimised in the interest of efficiency, otherwise construction targets may be affected. This matter deserves immediate attention of Commerce & Industry Ministry. It is therefore, suggested that a senior officer, who need not be a technical person, may be deputed for the liaison work in this connection.



CHAPTER VII.

COSTS OF PROJECT

7.1. The original estimate for the 1st stage of the Koyna Project as approved by the Planning Commission in 1953 was for Rs. 33.22 crores. This estimate had to be revised to Rs. 38.28 crores in October 1956 so as to accommodate (i) the technical modifications recommended by the Swiss Consultants and (ii) the higher rates tendered by the Contractors. The abstract of the estimate is given in Statement I. As this revised estimate is based on actual contractors' rates for most items as received by then, there need be little scope for future excesses over this amount. However, some of the possible excesses and savings as envisaged at present by the project authorities are given below :—

S.No.	Items	Amounts in crores of Rs.	
		Excess	Savings
I. Civil Engineering Works :			
1.	Extra cost on cement (due to revision of rates) ..	0.90	—
2.	Extra cost on steel (due to revision of rates) ..	0.05	—
3.	Extra cost on Tender for Power House (Sanctioned after Oct., '56 revision)	0.60	—
4.	Extra on land	0.40	—
5.	Other savings on preliminaries, buildings and miscellaneous	—	1.275
6.	Approach Tunnel and Ventilation Tunnel ..	—	0.063
9.	Contingencies at 3%	—	0.528
	SUB TOTAL	1.95	1.866
II. Electrical Mechanical Works :			
1.	Extra cost on cement	0.02	—
2.	Extra cost on steel	0.12	—
3.	Extra cost on ACSR Conductor	0.12	—
4.	Extra cost on creak crossing	0.10	—
5.	Contingencies at 3%	—	0.293
	SUB TOTAL	0.36	0.293
	GRAND TOTAL	2.31	2.159
	NET EXCESS	0.15	—

Thus, the net excess expected at present is of the order of Rs. 15 lakhs. Savings on contingencies may not come about as there are many clauses in contracts which may cause excesses. The establishment overheads may exceed if the works are not completed in time of which there is a possibility.

7.2. Planning Commission had provided about Rs. 5.77 crores during the 1st Five Year Plan, out of which Rs. 2.6 crores were actually spent. Funds sanctioned for Second Five Year Plan are Rs. 29 crores. Thus the spillover to Third Plan would be about $(38.28 + 0.15) - (2.6 + 29) = 38.43 - 31.6 = \text{Rs. } 6.83$ crores. However, the actual expenditure would depend upon how far the possible bottlenecks in the construction schedules are removed as discussed in the previous chapters. Rephasing of stage I & II proposed in Chapter V would very slightly, if at all, affect the expenditure. The phased expenditure as proposed by Chief Engineer, Koyna, along with the project, budgeted and actual expenditure figures is given in Statement II. It is evident therefrom that there is a continuous lag in the expenditure tempo. The total project forecast expenditure ending March 1958 was Rs. 18.87 crores, against which Rs. 18.65 crores were budgeted and only Rs. 9.07 crores were actually spent. In other words, the up-to-date progress is just about 50% of the targets of the original programme, thus necessitating a rephasing. This rephased programme also is not likely to be achieved unless deficiencies in construction programme as discussed in previous chapters are removed in which case the shortfall would be minimised. Even with the increased tempo the dam will be constructed by April 1961 upto a height just sufficient for working one turbine (in July 1961), only one pressure shaft will be completed by then and construction of remaining 3 turbines and generators will continue in the Third Five Year Plan.

7.3. The foreign exchange requirements as furnished by the Chief Engineer, Koyna are given in Statement III from which it is clear that out of a total requirement of Rs. 16.31 crores, up-to-date utilisation is Rs. 2.92 crores, and future liabilities are of the order of $16.31 - 2.92 = \text{Rs. } 13.39$ crores. However, these figures were computed on the assumption that all steel and cement may have to be imported which may not now be fully necessary. All cement is likely to be available from within the country. The foreign exchange required for 20 ton cableway or any alternative device recommended by the Team can be met with from the provision under construction and other equipment.

STATEMENT I

Oct. 1956 Estimate of 1st stage of the Koyna Hydro Electric Project.

	Civil Engineer- ing Branch	Electri- cal and Mechani- cal Branch	Total
I—Works			
A—Preliminary Investigations	52.50	—	52.50
B—Land and Rehabilitation.	54.50	5.50	60.00
C—Works			
(i) Dam and appurtenances	995.00	—	995.00
(ii) Intake to Emergency valve tunnel ..	391.00	—	391.00
(iii) Pressure shafts, power house and appurtenances	373.00	—	373.00
(iv) Tail race	112.00	—	112.00
(v) Generating and step-up plant	—	411.00	411.00
(vi) Transmission Lines	—	357.00	357.00
(vii) Receiving Station	—	165.00	165.00
K—Buildings	135.00	13.50	148.50
M—Plantation Parts and Gardens	3.00	—	3.00
O—Miscellaneous	201.00	36.00	237.00
P—Maintenance and running Charges ..	73.50	16.00	89.50
Q—(i) Special tools & plant	96.00	13.50	109.50
(ii) Construction power house	—	57.50	57.50
S—Consultants	12.00	4.00	16.00
TOTAL WORKS	2498.50	1079.00	3577.50

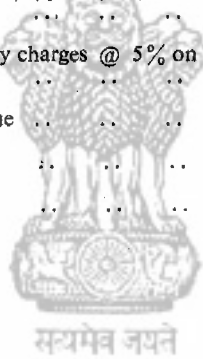
II.—Establishment.**A—Supervisory**

(i) @ 7 1/2% except for A,B,Q & S for Civil & A, B & C for E. & M. Works	174.00	81.00	255.00
(ii) @ 5% on 'B'			

B—Central Accounts	6.70	3.30	10.00
----------------------------	------	------	-------

C—Miscellaneous	—	—	—
-------------------------	---	---	---

	Civil Engineer- ing Branch	Electrical and Mechani- cal Branch	Total
III—Tools and Plant			
@ 1% on works except A, B, Q & S for Civil Works & A, B & S for E. & M. Works.	23·00	11·00	34·00
IV— <i>Suspense</i>	10·00	2·70	12·70
V— <i>Receipts on capital accounts.</i>	96·00	39·00	135·00
VI—Indirect charges			
(A) Audit charges @ 1% on I, III, IV & V.	26·30	11·30	—
(B) Secretariat charges @ 1/2% on I, III, IV and V.	13·20	5·70	—
(C) Leave and pensionary charges @ 5% on II.	9·00	4·20	—
(D) Abatement of revenue	4·00	..	—
TOTAL OF VI	52·50	21·20	73·70
TOTAL	2668·70	1159·20	3827·90
Say Rs. 3828·00			



STATEMENT II
Phased Budgeted and Actual Expenditure

		Expenditure					
		1956 Project Report		Budgeted		Revised (phased) April 1958	
		Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
Upto March 1954	..	—	—	*19-67	*19-67	*19-67	*19-67
1954-55	..	101-69	101-69	175-88	195-55	92-05	111-72
1955-56	..	216-84	318-53	401-25	596-80	147-54	259-26
1956-57	..	534-60	853-13	582-37	1179-17	196-88	456-14
1957-58	..	1034-36	1887-49	685-98	1865-15	451-32	907-46
1958-59	..	821-38	2708-87	—	—	850-22	1757-68
1959-60	..	757-16	3466-03	—	—	1046-10	2803-78
1960-61	..	333-26	3799-29	—	—	757-28	3561-06
1961-62	..	27-19	3826-48	—	—	263-34	3824-40
1962-63	..	1-42	3827-90	—	—	3-50	3827-90

*These figures are taken from Chief Engineer (Koyana)'s letter No. G-82/2644 of 29-3-58 addressed to Secretary I & P Team.

STATEMENT III

Koyna Hydro Electric Project—1st Stage Estimated requirements of foreign exchange

S. No. (1)	Item (2)	Up to 31-3-57 (3)	(in Rs. Millions)					REMARKS		
			1957-58 (4)	1958-59 (5)	1959-60 (6)	1960-61 (7)	1961-62 (8)	1962-63 (9)	Total (10)	(11)
1.	Generation & Step up Plant	—	2.38	7.79	11.78	6.30	1.23	0.15	29.63	Foreign Exchange released up to the end of March 1958 for :—
2.	Transmission & Switching Station	1.57	5.70	7.43	2.08	0.15	—	—	16.93	(a) Construction and other equipments Rs. in millions 28.50
3.	Receiving Station	—	—	2.33	7.49	0.72	0.16	—	10.70	
4.	Construction Plant	1.40	1.26	—	—	—	—	—	2.66	(b) Consultants' fees .. 0.75
5.	Fuel & Lubricating Oils ..	0.47	1.31	1.65	1.33	0.52	—	—	5.28	Total Rs. 29.25
6.	Construction & Other equipment	7.2	10.2	6.0	6.0	2.6	—	—	32.0	
7.	Consultants fees, Foreign salaries and services	0.75	0.95	1.65	1.65	1.3	0.7	—	7.0	
8.	Steel	0.3	2.6	9.2	3.9	—	—	—	16.0	
9.	Cement	0.5	0.5	10.2	10.5	11.5	3.2	—	36.40	
10.	Miscellaneous items such as fuels, explosives etc.	0.3	2.0	1.7	1.7	0.5	0.3	—	6.5	
TOTAL ..		12.49	26.90	47.95	46.43	23.59	5.59	0.15	163.10	

STATEMENT IV
Cost and plinth areas of Residential Buildings provided on different projects

S. No.	Name of Project	Chief Engineer			Superintending Engr.			Executive Engr.			Dy./Asstt. Engr.			Overseer/Supervisor		
		Plinth area sq'	Total cost Rs.	Cost/sq' Rs.	Plinth area sq'	Total cost Rs.	Cost/sq' Rs.	Plinth area sq'	Total cost Rs.	Cost/sq' Rs.	Plinth area sq'	Total cost Rs.	Cost/sq' Rs.	Plinth area sq'	Total cost Rs.	Cost/sq' Rs.
1.	Koyna Project (Bombay)	2724	44,400	16.33	2207	28,225	11.98	1875	22,555	12.03	1242	14,780	11.9	587	5932	10.1
	(Not Built)															
2.	Bhadra Project* (Mysore)	—	—	—	1900	15,200	8.00	1341	8,600	6.44	976	6,800	7.06	458	1600	3.50
3.	Hirakud* (Orissa)	5,163	76,010	14.7	4555	37,300	8.19	—	—	—	3088	28,328	9.28	—	—	—
4.	Bhakra* (Punjab)	—	52,000	—	2815	17,770	6.30	1600	8,283	5.12	1367	7,000	5.12	689	4600	6.50
5.	Chambal Hydrl* (Madhya Pradesh).	2918	33,732	11.56	2233	23,761	10.50	1712	19,474	11.4	1236	13,751	11.00	604	6136	10.15

*Transcribed from Appendix—2, on page 350 of Rates & Costs Committee's Report.

7.4. The expenditure on establishment as provided in the estimate is 7 1/2%. Year to year expenditure up-to-date, on this item is as shown below :

Years	Expenditure on work portion (lakhs)		Expenditure on Estt. (lakhs)		Percentage Estt. costs.	
	Year-wise	Cumulative	Year-wise	Cumulative	Year-wise	Cumulative
1954-55	71.02	71.02	13.44	13.44	19%	19%
1955-56	124.71	195.73	17.32	30.76	13.8%	15.4%
1956-57	162.63	358.36	21.30	52.06	13.0%	14.6%
1957-58	407.72	766.08	27.11	79.17	6.7%	10.4%

The overhead expenditure on establishment is coming down gradually. If the project is completed as programmed by April 1962, there may not be any excess under this head but any delay beyond that target will mean an extra expenditure of about Rs. 40 lakhs per year.

7.5. A notable feature of this project is that the residential and office buildings as provided for various categories of personnel are of very moderate standards, both in construction details and extent. A comparison of plinth area and cost per unit plinth area as provided for different category of construction personnel on some projects is given in statement IV, which reveals a great deal of diversity. It is better that provision of such amenities should be of a uniform standard throughout the country and the considerations of economy on such items should operate uniformly. We recommend that this matter may be considered in all its details by Ministry of Irrigation and Power with a view to laying down uniform standards, both as regards type of construction and size of accommodation. While formulating such standards, the Ministry may also consult the Buildings Projects Team of COPP.

CHAPTER VIII

AGENCIES OF CONSTRUCTION

8.1. The rates in 1953 estimate amounting to Rs. 33.22 crores on which the work was started, were based on whatever data were available for similar projects elsewhere in India and also on the analysis of the rates of the various items. The rates were fixed on the following assumptions :—

- (i) Mechanisation of work compatible with speed and economy.
- (ii) Construction by contract.
- (iii) The personnel operating the machine to be indigenous as far as possible.
- (iv) No salvage value for the plant and equipment utilised.

The rates adopted were considered to be realistic. It was expected that the maximum outlay on plant and machinery would be about Rs. 300 lakhs, but no provision was made for this amount, as the rates adopted were all inclusive and the expenditure was recoverable from the rates of the items. The scheme was inaugurated in January 1954. The work was started on preliminaries like colonies, roads, water supply, drainage etc. in the usual departmental manner.

8.2. The question of undertaking the major items of works like dam and appurtenances, head race tunnel, tail race tunnel, pressure shafts and power house departmentally or by contract was then considered. A technical sub-committee was appointed by the Koyna Control Board during its tenth meeting of May 1955 to report among other things whether the Koyna Project should be executed through contractors or departmentally. The report of this sub-committee (Appendix VII) did not envisage any insurmountable difficulty in the way of departmental execution of the Project. The Koyna Control Board in its eleventh meeting held on 10th June, 1955 resolved that this question should be gone into after all tenders were received.

8.3. Before inviting tenders for the major items of work, detailed conditions and specifications of contract were prepared. On the basis of these specifications and conditions, global tenders were invited in May 1955 for :—

- (1) Dam and appurtenances,
- (2) Approach and ventilation tunnels and
- (3) Intake to emergency valve tunnel.

A period of about six months was given for receiving the tenders.

8.4. A sub-Committee was appointed by the Koyna Control Board to scrutinise the tenders for the three works mentioned above. Six tenders were received for the work of intake to emergency valve tunnel which was estimated to cost Rs. 2,01,70,000 and four tenders were received for the approach tunnel and the ventilation tunnel estimated to cost Rs. 31,30,000. All these tenders were from Indian firms of contractors. Six tenders were received for the construction of Dam and Appurtenances. Four of these firms were entirely Indian, one was Indian with German associates and one was French Group of Engineers. As the lowest suitable tenders exceeded the estimated cost by 19% to 30% in the case of works mentioned in Statement-I, the Chief Engineer, Koyna Project does not seem to have been in favour of letting out the works to contractors. In the case of construction of Dam, he definitely recommended that the work should be carried out departmentally by employing piece workers or petty contractors wherever possible, in spite of the difficulties which were likely to be experienced in obtaining sanctions to purchase of machinery etc. departmentally and other difficulties which he mentioned in his forwarding note. This question was discussed at the sixteenth meeting of the Koyna Control Board held on 9th February 1956 and a decision was taken to accept the tenders for these works. No detailed reasons are available on record as to why, in spite of the Chief Engineer's advice to do the work departmentally, the works were let out on contract at much higher rates than those in the estimates.

8.5. In the Seventeenth meeting of the Koyna Control Board held on 3rd and 4th May 1956, the question of executing the tail race tunnel departmentally or by contract was considered and it was decided to undertake the work departmentally as suggested by the Minister for Planning, Government of India (vide appendix VIII.) This has proved to be a wise decision in view of the fact that the actual cost of underground excavation is working out much cheaper than similar work given out to the contractors in Head Race and other Tunnels. From the analysis of cost of underground excavation for the Tail Race Tunnel obtained from Koyna Organisation, (vide Statement-II) the rate is working out to Rs. 102/- per hundred cu. ft. against Rs. 152/- for similar work for Head Race Tunnel which is being done on contract vide Statement-I. The concrete lining of this tunnel is also proposed to be executed departmentally. This being the only work undertaken departmentally, it should provide valuable data regarding the actual rates for important items of works such as (i) underground excavation in rock and (ii) concrete lining of tunnels.

STATEMENT I

A—Abstract of Excesses over estimates in 3 major tenders

S. No.	Name of work and Agency	Cost in crores of Rs.			%Excess
		Estimated	Tendered	Excess	
I.	Pressure shafts, Power House, and Appurtenances Hindustan Construction (Private) ..	2.04	2.66	0.62	30.4%
II.	Dam and Appurtenances M/s. Shaha Salzgitter & Jolly (Private) Ltd.	6.57	7.84	1.27	19.3%
III.	Intake to Emergency Valve Tunnel M/s. Patel Engineering (Private) Ltd.	2.02	2.57	0.55	27.2%
	TOTAL	10.63	13.07	2.44	22.9%

*B—Details of some items of works where the bulk of excess is concentrated.**I.—“Pressure shafts, Power House and Appurtenances”—H.C.C.*

S. No.	Item	Q (MCFT)	Estimated		Tendered	
			Rate Rs.	Amount lakhs	Rate Rs.	Amount Rs. lakhs
1.	U/G Exc. for Pressure shafts ..	0.48	320	15.38	297	14.28
2.	U/G Exc. for, valve house Machine Hall, workshop, Transformer hall passage, passage to control Room, other passages and transformer hall, and Control Room	6.66	130	86.56	168	111.14
3.	Concreting for pressure shafts	0.26	300	7.84	456	12.92
4.	Concreting arching for pressure shafts and penstocks, arching for Machine Hall, workshop, transformer hall, Control Room, and all other passages to these halls and galleries	0.482	300	14.58	470	22.68
5.	Concrete walling for Da Do and valve house	0.32	300	9.71	480	15.55
6.	Concrete arching for valve house	0.037	300	1.11	485	1.79
7.	Concrete for transformer hall slab	0.15	275	4.10	540	8.05
8.	C. R. Masonry with U. C. R. hearting in C M (1.4) for switchyard	0.192	135	2.59	174	3.34
	TOTAL			141.87		189.75
				Excess		47.88

II—Dam and Appurtenances—M/s. Shaha S. & J.

S. No.	Item	Q (M.C. Ft.)	Estimated		Tendered		Excess
			Rates	Amount	Rates	Amounts	
1.	Rock excavation foundation	12.3	34	41.82	48	59.00	
2.	Ex. in rock for stilling basin	2.5	28	7.00	40	10.00	
3.	Providing cement and pressure grouting with cement slurry at 300 PSI	25,000 cwt.	8	2.00	50	12.50	
4.	Cement concrete class A for Dam	15.8	230	363.40	265	418.70	
5.	Cement concrete class B for Dam	3.1	200	62.00	250	77.50	
6.	Rubble stone in the Rubble concrete for Dam	12.4	65	80.66	82.50	102.37	
7.	Course Rubble Masonry facing and U. C. R. hearting in 1.4 C. M. for training wall of spillway basin and piers of spillway bridge	0.754	135	10.17	190	14.33	
TOTAL ..		—	—	567.05		694.40	127.35

*III. Works from intake to Emergency Valve Tunnel
(M/s. Patel Engineering Co.)*

S. No.	Item	Q M.C.Ft.	Estimated		Tendered		
			Rates	Amounts	Rates	Amounts	
1.	Head Race Tunnel—under-ground excavation :—						
	(a) Rock requiring no supports	4.7	170	80.0	154	72.32	
	(b) Rock requiring supports	0.578	170	9.7	152	8.70	
2.	Cement concrete lining for tunnels :						
	(i) 12" thick	0.65	300	19.63	600	39.27	
	(ii) 15" thick	0.0456		1.37		2.73	
	(iii) 18" thick	0.204		6.12		12.24	
3.	Cement concrete class A behind steel lining						
	(i) 12" thick	0.10		3.02	570	5.745	
	(ii) 15" thick	0.052		1.58		3.00	
	(iii) 18" thick	0.012		0.38		0.72	
	(iv) Near Intake gate	0.026		0.78		1.49	
4.	Surge:—Underground excavation in rock.						
	(i) Gantry House .. .. .	.248	160	11.4	137.	9.77	
	(ii) Shafts .. .. .	.465					
TOTAL				133.98		155.98	
				Excess		22.00	

STATEMENT-II

TAIL RACE TUNNEL

Analysis of cost of underground excavation

	Cost per brass (Rs.)
1. Drilling	9·540
2. Blasting	17·920
3. Mucking	11·753
4. Ventilators	0·352
5. Plant	36·139
6. Miscellaneous	8·139
7. Cost of rent of buildings (at six per cent on one-third cost of all buildings allotted to the Plant and Machinery Division Pophali)	1·885
8. Cost of Establishment (one-third of cost of the Division) ..	5·277
9. Furniture etc.	0·138
10. Insurance, Compensation, Supervision interest etc.	6·291
	<hr/>
TOTAL ..	97·473
Add for additions and omissions	5·000
	<hr/>
GRAND TOTAL ..	102·473

Rs. 102·473 cost per brass.

Sd/-
for Chief Engineer, Koyna.

8.6. From the tender papers attached to the Koyna Control Board proceedings, Statement-I is prepared which shows (A) Abstract of excesses over estimates in 3 major tenders and (B) Some items of works where the bulk of excess is concentrated. It will be seen that on some of the important items like concreting of the head race tunnel and pressure shafts, the excess in the tender rate is 50% to 100% over estimates. Some of these rates seem to be high.

8.7. A list of the construction agencies for all the important works appears in Statement—III from which it would be observed that the works are distributed over a wide range of firms. The completion dates for the first five major civil works are also shown in the same statement.

The concreting of the dam is not likely to be completed by 31st April 1960 as per tender. The target date for completing the dam to a sufficient height to feed one turbine has been shifted to 31st April 1961 but this too is not likely to be attained unless steps are taken to increase the output of rubble concrete as discussed in chapters V & VI.

The work of Approach and Ventilation tunnel has been completed.

The work of Intake to Emergency Valve Tunnel is scheduled to be completed by 31st March 1960 which is also the tender date. The progress of tunnel excavation is satisfactory. The concrete lining has not yet been started but from the arrangements made for procurement of forms etc. it is expected that the concrete lining will be completed in time.

According to the tender the work of Pressure Shafts is to be completed by 31st March 1960 for the 1st Shaft and 31st March 1961 for the 2nd Shaft. According to the revised schedule of construction the work of concrete lining including the steel lining is expected to be completed in November 1960 for the 1st Shaft and May 1961 for the 2nd Shaft. These may not be attained as explained in Appendix IV-B. In any case 1st Shaft must be completed by March 1961, if the power is to be generated by July 1961.

8.8. In all these tenders for major civil works there is a number of special clauses described in Appendix IX which may increase the cost and also make it difficult to enforce penalties against the contractors. According to these tenders the Govt. is to provide funds to the extent of 90% for all new machinery required by the contractors and 75% of the cost of colonies constructed by the contractors for their labour and staff. All services like water-supply, electricity and roads have to be provided by the Government. All foreign exchange, supply of steel and cement has to be arranged by the Government.

STATEMENT-III

*Agencies of Construction**(Contracts)*

S. No.	Name of work	Amount of work in lakhs of Rs.	Name of contractors (or suppliers)	Tendered date of Completion
(1)	(2)	(3)	(4)	(5)
1.	Constructing a rubble concrete dam on the river Koyna.	788.9	Shaha Salzgitter and Jolly Ltd.	Dams : 30-4-60 Spillway Gates : 31-3-61.
2.	Approach and Ventilation Tunnel.	31.4	Patel Engineering Co., Bombay.	Approach : 31-12-56 Ventilation : 31-5-56.
3.	Intake to Emergency Valve Tunnel.	257.4	Patel Engineering Co., Bombay.	31-3-60.
4.	Pressure Shafts, Power House and Appurtenances.	275.0	Hindustan Construction Co., Bombay.	1st shaft : 31-3-60. 2nd shaft : 31-3-61. Power House : 31-5-59.
5.	Steel lining in Tunnels & Pressure Shafts.	145.2	Indian Hume Pipe Co., Bombay (to be finalised).	31-3-60/61.
6.	Turbines	69.8	Neyrpic (France)	
7.	Generators	73.9	A. E. G. (Germany).	
8.	Transformers (Gen. Stn.)	34.9	Marelli (Italy).	
9.	Towers and accessories, Insulators and Accessories and erection (220 KV Transmission Lines).	95.0	Kamani Engineering, Corporation, Bombay.	
10.	Power-Conductor and Accessories (220 KV Transmission Lines).	104.7	Aluminium Industry Ltd.	
11.	125 MVA Auto Transformers (Receiving Station).	29.5	English Electric Co.	
12.	Synchronous Condensers. (Receiving Station).	17.6	Marelli (Italy).	
13.	Power House Cranes ..	11	Litostroj Titavi Zavedi (Yugoslavia).	

8.9. It would thus be seen that the major works of dam and pressure shafts cannot be completed by the tendered dates. If adequate steps are taken, it may be possible to generate power in July 1961, i.e., one year after the scheduled date.

8.10. As most of the operations in all these works are mechanised, it is a for consideration whether works of this kind, in which considerable plant and machinery is required for execution and in which the construction work extends over a number of years, should be let out on contract or executed departmentally employing Government machinery and small labour contractors or piece-workers.

8.11. When such large works are put to tender, the contractors provide for all sort of contingencies which may or may not arise. Besides, the contractors' rates usually include write-off of most of the plant and machinery, although they have considerable residual value. Contractors have to allow for a fair margin of profit. Due to these reasons their rates are naturally high. The tenders are usually hedged in by many special clauses which contractors put in to safeguard their interests. Besides services like water-supply, electricity, roads and important materials like steel and cement have to be provided by the Government. Also foreign exchange and funds for machinery and colonies have to be supplied by the Government. The contracts for this project provide for payment of compensation by the Government in the case of failure to supply cement, steel, electricity and water in due time, as detailed in Appendix IX. After completion of the works the Government has no lien on plant and machinery for which foreign exchange has been made available by the Government.

8.12. In view of all these factors, it would seem to be advisable that works of such magnitude, involving use of considerable machinery and plant and extending over a number of years, should be executed departmentally using Government machinery and employing small contractors or piece-workers. Of course in the case of departmental execution there are many difficulties such as delays in procurement of machinery and spare parts, getting sanctions to the necessary staff and in fixing the salary of the people working on the machinery etc. If these difficulties can be successfully overcome, there should be considerable savings in departmental execution of such large projects.

8.13. There has been a growing tendency towards curtailment of the powers of the Chief Engineers specially after the separation of the Chief Engineer's post from that of the Secretary to Government. For efficient departmental execution of such large projects, the Chief Engineer should be vested with full powers to give technical sanctions.

within project provisions, to place orders for plant and machinery required for the project after inviting public tenders, to order spare parts as and when required and to employ work-charged staff on suitable salaries after making detailed provision in the working estimates.

8.14. A Code of rules delegating necessary powers to the Chief Engineer for efficient, speedy and economic execution of such large projects departmentally should be framed. Under the existing procedures and rules, the departmental execution is often found to be tedious, tardy and sometimes uneconomical.

8.15. Where works do not involve large-scale use of machinery and which do not extend over a long period, competitive rates can be obtained and these works can be executed with a reasonable economy through contractors.

The works requiring considerable fabricated steel such as steel sheet-lining of the shafts and tunnels in Koyna Project, for which there are specialised commercial firms can also be executed through contractors unless well-equipped departmental workshops are available.

17th January 1959.

N. V. GADGIL,
Leader.



CHAPTER IX.

SUMMARY

9.1. The present Koyna scheme envisages utilising 67,500 million cu. ft. of water for an installed generating capacity of 4,80,000 KW of electricity and providing 41,000 million cu. ft. of water for irrigation purposes. The first stage of the scheme, in its present form to develop 240,000 KW of power, was finalised in December 1952 when it was estimated to cost Rs. 33.22 crores. This estimate was revised to Rs. 38.28 crores in October 1956 so as to accommodate the technical changes recommended by Swiss Consultants and the higher tendered costs. The delivery of power was scheduled for October 1960 and it has now been revised to July 1961.

9.2. Establishment for the project is sanctioned from year to year. The Team however recommends that an overall sanction should be given for the period of the project and the Chief Engineers authorised to operate thereon. This will save time and labour both of the Chief Engineers and the Control Board.

The Team further recommends the following with a view to providing necessary incentive to the temporary personnel on the Project :—

- (i) Immediate implementation of the Control Board's recommendation to give temporary subordinate staff a lien in permanent Circles of Public Works Department; and
- (ii) Immediate creation of permanent posts, both gazetted and non-gazetted, required on completion of the Project and absorbing deserving personnel against them.

9.3. All the 240,000 KW of electricity generated on completion of the first stage of the project is expected to be consumed by October 1964 and therefore it would not be possible to postpone the second stage by ten years as originally contemplated. It is therefore necessary to merge the second stage with the first and to rephase the project so that the fifth unit of the Project is commissioned soon after October 1964. It would therefore seem necessary that the dam should be raised in continuation of the first stage to a height sufficient to store 57,000 M. C. Ft. of water required for second stage power generation.

9.4. The cost and selling rate of power are stated in October 1956 Project Report as 0.38 and 0.45 anna per unit respectively. These rates are neither related to what the industries can pay without detriment to their progress nor to costs of thermal power as an alternative.

It is hoped that the Tarrif Committee will duly weigh these factors and decide upon tariffs which, after meeting the working expenses, interest and depreciation charges, will yield sufficient surplus for reserves and contingencies.

9.5. It is the view of the Team that the main concern in utilisation of power should be to avoid concentration of industries in Bombay area, if the problems arising from such concentration are to be avoided. It would therefore be desirable to give priority to the establishment of as many industries in the Koyna area as possible, thereby enabling exploitation of the natural resources locally available such as bauxites as well as other raw materials which can be economically brought by sea for electro-chemical and other industries.

9.6. The ample tail waters should help in developing the Dabhol Creek into a port. The potentiality of this Creek in this regard needs to be speedily assessed and exploited.

9.7. It should be possible to irrigate about 5,000 acres of land on the banks of the tail race channel by diverting a fraction of the tail waters. This as well as other possible uses of tail waters such as water supply to towns and villages etc. should be investigated.

9.8. The Koyna Dam was originally planned to store 98,000 M.C.Ft. of water (57,000 for power, 31,000 for irrigation in Satara and Bijapur Districts and 10,000 for carryover). Since November 1956 Bijapur District has been transferred to the reorganised Mysore State. In May 1958 the Bombay Government decided to utilise 16,000 M. C. Ft. of water for flow irrigation of about one lakh acres in North and South Satara Districts in Bombay State. The project estimate for this irrigation scheme is not yet ready. The feasibility of this irrigation scheme therefore cannot be judged at present. The Government of Bombay addressed the Government of Mysore in May 1958 regarding sharing the cost of storage required by Mysore State. The Mysore Government has not yet taken a decision. The two States should come to an early agreement so that the programme of construction for the full development can be finalised.

9.9. The Team wishes to stress the importance of undertaking the immediate re-allocation of Krishna waters, consequent to reorganisation of States.

9.10. The tempo of some of the works like concreting of the dam and excavation of pressure shafts is not at present adequate to achieve the revised target of power generation in July 1961. The capacity of the concreting rig is only about 60% of that required for completing the job in time and needs to be supplemented immediately. Similarly

steps need to be taken to improve the technique of excavation of the pressure shafts so as to achieve the required progress. The steel lining of pressure shafts may also prove a bottleneck and may require foreign expert supervision. The project authorities have standing arrangements with their Swiss Consultants for obtaining advice and assistance of experts in the line when necessary. This may be availed of if any difficulty is experienced.

9-11. The Thana Creek Crossing which is a complicated work may prove yet another bottleneck unless immediate steps are taken to start construction there.

9-12. According to October 1956 estimate, the spillway portion of the dam was to be constructed to full width required for the final storage of 98,000 M. C. Ft. both in foundation and superstructure. In the non-spillway portion the foundations were to be of full width required for the final storage, but the superstructure was to be of a width required for the 1st stage storage of 36,000 M. C. Ft. On account of the expected rapid load development, as it would not have permitted of a time lag of ten years between construction of 1st and 2nd stages which was considered necessary for attaining equilibrium of the 1st stage concrete before the 2nd stage concrete could be started, the Bombay Government have modified this programme. In this modified programme it is proposed to construct foundations of the spillway portion to full width required for final storage, but the superstructure has been reduced to suit a storage of 73,000 M. C. Ft. required for power and irrigation in Bombay State. The non-spillway portion is proposed to be constructed both in foundation and superstructure of width required for a storage of 73,000 M.C. Ft. This modification in the programme is likely to make the construction work for the final storage of 98,000 M. C. Ft. both difficult and costly. The cost of the extra work on dam for storing 98,000 M. C. Ft. instead of 73,000 M. C.Ft. will be only Rs. 2.2 crores. This extra cost is amply justified both on account of the additional benefits of power and irrigation.

The modification in the construction programme to finish both the foundation and the superstructure of the dam to full width required for 98 T.M.C. Ft. storage would involve an additional quantity of 3.7 M. C. Ft. to be finished by May 1961. It is understood that this increase in quantity of concrete to be finished by May 1961 will lead to complications with the contractors in respect of rates and completion programme. It is considered that any further postponement in generation of power will have serious dislocating consequences in the industrial activity in Bombay region. In view of these difficulties it would not be advisable to alter the programme of construc-

tion materially. It is, however, considered that there will be great difficulty in thickening the superstructure of the spillway portion later on. Apart from constructional difficulties, there will be very limited time during the working season to do this work. The total extra quantity of concrete involved in this work is 0.88 M. C. Ft. of which only 0.55 M. C. Ft. will need to be done before May 1961. This will mean an increase of about 2% in the quantity of concrete or about a fortnight's work for the concrete laying equipment. The Team, therefore, recommends that the present programme of construction may be adhered to except for the small modification suggested in the spillway superstructure in constructing it to a thickness required for ultimate storage of 98,000 M. C. Ft.

After completion of the 1st stage work, the work of the 2nd stage should be carried out in continuation upto the level for storage of 57,000 M.C.Ft. required for power.

Subsequent work should be coordinated with irrigation schemes of the Koyna both in Bombay and Mysore.

9.13. In view of the necessity to develop the 2nd stage power by 1965, the 3rd and 4th pressure shafts and second cable tunnel will also have to be completed before that time. This work may be carried out departmentally as rock excavation work at present being executed by the department is much cheaper than similar work done through contractors. It would be desirable to take up this work immediately the tail race tunnel, which is being executed departmentally, is finished. This should be suitable as it would combine organisational interests with the requirements of the project.

9.14. The Dam is being built in rubble concrete which weighs more but costs less than ordinary concrete. Therefore, successful development of the technique of laying such concrete would go a long way in providing a cheaper alternative to pure concrete.

9.15. It is suggested that a senior officer may be deputed for liaison work to arrange for the import licenses etc. At present there are considerable delays in obtaining them. This matter deserves immediate attention of Commerce and Industry Ministry, as there is the risk of targets not being attained, if such delays are not avoided.

9.16. The project authorities anticipate an excess of Rs. 2.31 crores on certain items and a saving of Rs. 2.16 crores on other items. No major excesses are anticipated.

9-17. The total project expenditure forecast for the period ending March 1958 was about Rs. 18.9 crores and the actual expenditure was only Rs. 9 crores. This has necessitated rephasing of expenditure.

9-18. A comparison of provision of residential area and expenditure thereon for different categories of personnel on various projects reveals a great deal of diversity. The Team recommends that the Ministry of Irrigation & Power should lay down standards both for type of construction and size of accommodation in consultation with the Buildings Projects Team of COPP.

9-19. The tenders for the works of Dam and Appurtenances, Approach and Ventilation Tunnels and Intake to Emergency Valve Tunnel, have all exceeded the estimated cost by 19 to 30%. On some of the important items like concreting of the head race tunnel and pressure shafts the excess is of the order of 50 to 100%. Under the terms of contracts 90% of funds are advanced and foreign exchange provided to the contractors for purchase of machinery. In spite of these high rates and the facilities provided to the contractors, the works are not likely to be completed within the target date of October 1960 for generation of power. Therefore, the Team is of the opinion that such large works involving use of heavy machinery and extending over a number of years may be carried out departmentally using Government machinery and employing small contractors or piece-workers.

9-20. There has been a growing tendency towards curtailment of the powers of the Chief Engineers specially after the separation of the Chief Engineer's post from that of the Secretary to Government. For efficient departmental execution of such large projects, the Chief Engineer should be vested with full powers to give technical sanctions within project provisions, to place orders for plant and machinery required for the project after inviting public tenders, to order spare parts as and when required and to employ work-charged staff on suitable salaries after making detailed provision in the working estimates.

9-21. The work of tail race tunnel is the only big work being executed departmentally. The rate of underground excavation of the tunnel as reported by the Chief Engineer is about 66% of the contractor's rate for similar work. Valuable data will be available when the concrete lining of this tunnel is completed departmentally.

9-22. The Team is glad to place on record that this large and complicated project was investigated thoroughly and has been prepared carefully, and that its execution is vested in an authority of the proper type.

APPENDICES



सत्यमेव जयते

APPENDIX I

SALIENT FEATURES OF KOYNA HYDRO-ELECTRIC PROJECTS.

<i>I—Reservoir:</i>		1st stage	2nd stage	3rd stage
Catchment area, Sq. Miles	.. ..	344·32	344·32	344·32
Capacity at F.S.L., M.c. ft.	.. ..	36045	98780	98780
Water spread at F.S.L., sq. miles	.. ..	20·95	44·54	44·54
<i>II— Dam:</i>				
Top of parapet, K.R.L.	.. ..	2110·5	2174	2174
Crest of dam, K.R.L.	.. ..	2107·5	2171	2171
F.S.L., K.R.L.	.. ..	2088	2171	2171
M.W.L., K.R.L.	.. ..	2101·5	2165	2165
Minimum draw off level K.R.L.	.. ..	2000	2000	2000
Sill of spillway gates K.R.L.	.. ..	2061	2131·5	2131·5
Inlet sill of Irrigation sluices K.R.L.	.. ..	1990	1990	1990
Inlet sill of scouring sluices K.R.L.	.. ..	1960	1960	1960
Centre line at inlet of power penstocks, K.R.L.	.. ..	1975	1975	1975
Power penstocks	.. ..	2 Nos., 96 inches diameter		
Height at deepest section, ft.	.. ..	265·5	329	329
Length of spillway section, ft.	.. ..	291	291	291
Gates for spillway	.. ..	6 Nos., 41ft. X 27 ft.		
<i>III—Intake & Head Race :</i>				
Intake channel length, ft.	.. ..	3720	3720	3720
Head Race tunnel length, ft.	.. ..	12040	12040	12040
<i>IV— Pressure Shafts :</i>				
<i>(i) Main :</i>				
Nos.	.. ..	2	4	4
Length each, ft.	.. ..	2066	2066	2066
Size	.. ..	10' to 8'-6" diameter, circular.		

APPENDIX I—(contd.)

(ii) Tail Race Development (Tentative)

Nos.	1
Size	17 ft. circular.
Length ft.	500 ft.

V—Power House & Appurtenances:

(i) Main :

Power House (Machine Hall)	.. 51' × 651'	51' × 51'	51' × 651'
Transformer hall	.. .. 42.5' × 616'	42.5' × 616'	42.5' × 616'
Approach tunnel	.. .. 2835' long,	22' wide with a semi-circular arch over 10'—9" vertical sides.	
Cable tunnel size.	6'-6"	wide segmental arch over 8'-9" vertical sides.	
Cable tunnels Nos. & length	1 × 1240'	1 × 1240'	1 × 1240'
		1 × 1500'	1 × 1500'
Control cable tunnels	7450' long,	9'-0" wide, with segmental arch over 8'-9" vertical sides	
Tail Race tunnel	.. .. 1185' long	26' wide, with semi-circular roof over 7'-6" vertical sides.	
Switchyard	.. .. 150' × 800'	150' × 800'	150' × 800'

(ii) Tail Race Development :

Power House	} Nor worked out.
Transformer hall	.. .. .
Approach tunnel	.. .. .
Cable tunnel	.. .. .
Emergency exit	.. .. .
Tail race tunnel	.. .. .

VI—Power generation (KW)@ 60% L.F.:

Main power house	.. .. .	240000	408000	408000
Number of units installed at main-power house	.. .. .	4	8	8

APPENDIX I—(concl'd.)

Tail race development	—	—	60,000
Dam power house (Seasonal) .. .. .	..	..	30,000
220 K.V. underground cables, yds. .. 7700	14300		Not worked out.

VII—Transmission and Distribution :

- (i) 220 KV double circuit line for
Bombay miles 150
- (ii) 220 KV Single circuit line to Karad .. 44
- (iii) 110 KV Double circuit line from
Karad to Sholapur 126
- (iv) 110 KV Single Circuit line Karad-
Satara and Karad-Sangli .. miles 80
- (v) 33 KV Double and Single Circuit lines .. 84
- (vi) 22 KV. Double and Single Circuit
lines 119
- (vii) 11 KV. Single Circuit lines 15

Not worked out.

VIII—Receiving, Switching and Sectionalizing Stations :

- (i) 220 KV receiving station near Bombay No. 1
- (ii) 220 KV Switching Station 1
- (iii) 220 KV Karad Sub-Station 1
- (iv) 110 KV Sub-Station 4
- (v) 33 KV. Sub-Station 4
- (vi) 22 KV. Sub-Station 7
- (vii) 11 KV. Sub-Station 1

N.B. :—Items (ii) to (vii) in VII and VIII above are taken from the Bombay Electricity Board's Scheme for this area.

APPENDIX II-A
CONSTITUTION OF CONTROL BOARD FOR KOYNA PROJECT
GOVERNMENT OF BOMBAY

PUBLIC WORKS DEPARTMENT

Resolution No. GKP. 2054

BOMBAY CASTLE (BOMBAY NO.-1), 18th June 1954.

Resolution—Preliminary work on Koyna Hydro-Electric Project, First Stage, administratively approved under Government Resolution, No. GKP. 1553, dated the 20th February 1953, for an estimated cost of Rs. 3,321.57 lakhs has already commenced and the work on the project proper will be taken up as soon as possible. A project of the magnitude of Koyna presents a number of peculiar problems which call for special attention and quick decision. It is therefore considered necessary to constitute a high powered body to take quick decisions on matters pertaining to the Project and to exercise general supervision over its execution. The Planning Commission has also recommended setting up of suitable machinery to secure full development as quickly and effectively as possible, of every large Irrigation and Power Project. In view thereof, the Government of Bombay is pleased to constitute a Board to be known as the "Koyna Control Board" for administering and supervising the execution of the Koyna Project.

2. The composition of the Board will be as under :—

Chairman—The Minister, Public Works Department.

Members—The Minister, Finance Department.

The Deputy Minister, Public Works Department.

The Secretary, Finance Department.

The Secretary, Public Works Department.

Shri S. L. Kirloskar, Poona.

The Secretary, Public Works Department, will also be the Secretary of the Board.

3. The Board will exercise general supervision over the Execution of the Koyna Project. It will enjoy the following powers :—

(i) To give financial sanction to specific detailed items of expenditure within the limits of budget provision in each year.

(ii) To make contracts and sanction tenders in respect of matters which may be beyond the limits of powers delegated to the Chief Engineers.

- (iii) To make variations of contracts and estimates, sanction for which may be beyond the competence of the Chief Engineers.
- (iv) To decide relaxations of recruitment rules in respect of non-gazetted staff, to sanction establishment, grant higher starting pay, etc.

4. The Board will take decisions on the matters referred to in paragraph 3 above and other administrative matters pertaining to the Koyna Project, but the formal orders implementing the Board's decisions will be issued by the Public Works Department after submission of the papers to Government in the Public Works Department, Finance Department, Political and Services Department or other Departments as the case may be. In urgent cases files would be marked to the Secretaries of the Departments concerned direct. To facilitate quick disposal, a copy of the minutes of the Board's meetings should be supplied to the Finance Department and other concerned Departments in addition to the copies sent to Minister, Finance Department and Secretary, Finance Department as Members of the Board.

5. The Koyna Control Board being a non-statutory body will have no direct dealings with the members of the Public. Formal documents will be entered into by the Chief Engineers or the Secretary, Public Works Department, as the case may be in accordance with the Board's decision.

6. The Board will be competent to delegate to the Chief Engineers or other Officers of the Koyna Project certain powers in connection with the execution of the project; it may also add to or limit the extent of their powers under the normal Public Works Department System.

7. Government may delegate to the Board additional powers as and when necessary.

8. The Board may frame detailed rules regarding the number of meetings to be held, the manner of recording minutes of its meetings, etc. and other matters connected with its working.

9. The non-official member of the Board will be eligible to draw travelling allowance and daily allowance admissible under the rules to the non-official members of State Committee for attending the meetings of the Board. The cost on that account and contingent expenditure should be met from the sanctioned grant for the Koyna Project.

By order and in the name of the
Governor of Bombay.

V. N. SARDESAI,
Secretary to Government.

APPENDIX II-B

KOYNA CONTROL BOARD (CONDUCT OF BUSINESS RESOLUTION)

In exercise of the powers conferred on it by paragraph 8 of Government Resolution, Public Works Department, No. GKP 2054, dated the 18th June 1954, the Koyna Control Board makes the following regulations.

1. *Short Title*.—These regulations may be called by the Koyna Control Board (Conduct of Business) Regulations.

2. *Definitions*.—In these regulations, unless there is anything repugnant in the context,

“Board” means the Koyna Control Board.

“Chairman” means the Chairman of the Koyna Control Board.

“Secretary” means the Secretary of the Koyna Control Board.

3. *Meetings*.—(i) The Board shall ordinarily meet once a month.

(ii) The Chairman may, however, at his discretion, call meetings of the Board at more frequent intervals to transact urgent business.

4. *Quorum*.—Any four members present shall form a quorum at a meeting of the Board.

5. *Notice of meeting etc.*.—(i) Notice of a meeting signed by such Officer as the Chairman may authorise shall ordinarily be given to every Member at least 7 days before the meeting. Emergency meetings may be called at twenty-four hours notice.

(ii) The Secretary shall prepare the agenda of every meeting in consultation with the Chairman and shall forward with the agenda notes on the items included in the agenda. Each note shall indicate the financial implication of the proposal and shall clearly bring out the point or points on which the Board's decision is sought. Before preparing his note the Secretary may, if considered necessary, call for the views of the Chief Engineer or the Secretariat Departments concerned.

(iii) The agenda and notes shall be circulated to the members at least 4 days before the meeting is held.

6. *Minutes* :—(i) The minutes of the Board shall be recorded by such Officer as the Chairman may authorise in this behalf.

(ii) Before finalising the minutes a tentative draft shall be circulated to all members present at the meeting for their remarks.

(iii) The minutes of the previous meeting shall be placed before the next meeting for confirmation.

(iv) The Chairman shall sign the minutes after their confirmation by the Board.

(v) The Secretary shall arrange to keep in proper order in a "minute book" all minutes of the Board's meetings duly signed by the Chairman.

7. *President of the meeting* :—The Chairman, when present, and in his absence one of the Members, nominated by the Chairman shall preside over every meeting of the Board.

8. *Decision by majority*.—Every decision of the Board shall be taken by a majority of the votes of the members. In the case of equality of votes, the Chairman shall have a casting vote.

9. *Sub-Committees* :—The Board may refer any matter to a Sub-Committee for consideration and report and take a decision thereon after the receipt of the report. The Sub-Committee may consist of such members of the Board, and such other persons, as the Board may nominate.

10. *Action on the Board's decisions* :—The decisions of the Board shall be implemented immediately after the Board's decision is taken, unless the Chairman otherwise directs.

11. *Decisions by Circulation* :—The Chairman may, at his discretion obtain the decision on any matter by Circulation. In such cases the notes on the matters requiring the Board's decision shall be circulated by the Secretary to the members of the Board. The opinion of the majority shall be the decision of the Board.

12. *Proceedings of the Board to be confidential* :—The proceedings of the meetings of the Board shall not be disclosed to any person without the consent of the Board.

APPENDIX II-C

CONDUCT OF BUSINESS RULES OF THE KOYNA CONTROL BOARD

PROCEDURE TO BE ADOPTED IN CASE OF URGENCY

The Board at its 24th meeting held on 6th April, 1957, decided that the following rule should be added as rule 5-A to the Conduct of Business Rules :—

5A—Procedure to be adopted in case of Urgency

(i) Whenever it is not possible to convene an ordinary meeting of the Board, as provided in rule 5 of the Rules, any financial, administrative or technical issues of a very urgent nature may be considered by a Sub-committee consisting of :—

- (1) The Secretary to the Government of Bombay, Public Works Department.
- (2) The Secretary to the Government of Bombay, Finance Department.
- (3) The Representative of the Government of India, Ministry of Irrigation and Power.

(ii) The Financial Adviser to Government for Koyna and other Major Projects and the Chief Engineer, Koyna, shall assist the Sub-Committee.

(iii) The Sub-committee shall submit its report to the Chairman of the Board for decision and the matter shall be placed before the next meeting of the Board for formal approval.

(iv) Meeting of the Sub-committee shall be convened by the Secretary, Public Works Department.

(v) Whenever in the opinion of the Secretary it is not possible or necessary to call a meeting of the Sub-Committee, he may circulate a note with the approval of the Chairman on the proposal under consideration to the members of the Sub-committee and obtain a decision by Circulation.

APPENDIX II-D

FUNCTIONS OF FINANCIAL ADVISER

Annexure

Broadly speaking the duties and functions devolving on the Financial Adviser would be as under :—

- (i) To keep himself in close touch with the pace of expenditure on the project and correlation of the progress of expenditure with the progress of work. The Financial Adviser will be required to submit a six-monthly progress report to the Control Board indicating the progress of work and the progress of expenditure with his observations.
- (ii) All proposals involving relaxation of rules will be referred to him.
- (iii) The scrutiny of budget estimates of the project and the scrutiny of all proposals for reappropriation of funds or additional appropriation.
- (iv) Annual financial stock taking of the project as prescribed under the rules.
- (v) Acceptance of tenders and award of contracts for works costing above certain monetary limits to be done in consultation with the Financial Adviser. Since huge amounts are involved association with the Financial Adviser will lead to healthy results. In this connection, it may also be mentioned that even for the C.P.W.D. contracts etc. there is a Central Works Advisory Board on which the Deputy Secretary, of the Ministry of Finance is nominated. The Central Works Advisory Board is doing useful work even in a well established Department like the C.P.W.D. and the association of the Financial Adviser in the matter of acceptance of tenders and award of contract should be in the best interests of the project.
- (vi) Association of the Financial Adviser with negotiations pertaining to contracts. It is needless to say that the financial representative on the Control Board or the Control Board itself will not be able to find the time for the negotiations which are to be conducted with the contractors, before the award of the contracts.

- (vii) Consultation by the Executive in the matter of preparation of schedule of rates.
- (viii) Consultation by the Executive for local purchase of stores above the prescribed limits.
- (ix) The cost accounting organisation on a project should work in close collaboration and consultation with the Financial Adviser.
- (x) Examination of all important financial proposals before submission to the Control Board.



APPENDIX III

Minutes of the discussion held with Mysore Engineers regarding storing irrigation water-supply for Mysore.

Present

Bombay

Shri G.N. Pandit,
Chief Engineer (I.P.),
Public Works Department.

Shri D.B. Anand,
Chief Engineer (I),
Public Works Department.

Shri N.G.K. Murti,
Chief Engineer, Koyna.

Shri V.R. Vaidya,
Chief Engineer (Elect.),
Koyna.

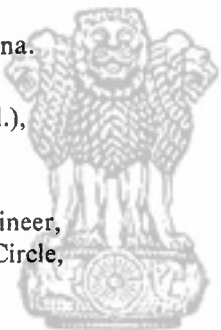
Shri P. M. Mane,
Superintending Engineer,
Dam and Designs Circle,
Koyna.

Shri B. S. Apte,
Superintending Engineer,
Water Resources Investigation Circle,
Bombay.

Shri B. G. Dholakia,
Executive Engineer,
Designs No. III,
Koyna.

Shri M. P. Mathrani, Member, I&P Team, Committee on Plan Projects, and Shri S. G. Balekundry, Executive Engr., I&P Team, also attended the discussion as observers.

1. Bombay Engineers stated that water to be stored in the Koyna dam will have to come out of the allocations of the Krishna waters to the Mysore State. Mysore engineers agreed.



2. Mysore Engineers requested for the following technical information :

(i) The cost of the Koyna dam for the three different heights under consideration viz., for storages of :

(a) about 36,000 M.C.Ft.

(b) about 73,000 M.C.Ft.

(c) about 98,000 M.C.Ft.

(ii) What would be their share of cost of storage ?

(iii) Whether Bombay can supply power from Koyna to the extent of about 24,000 K.W. for a period of about 10 years at Karad, (by which time their Sharawati power might be available) and if so, whether the rate of supply of power at 0.1 anna per K.W. hr. assumed in Shri Champhekar's Report for irrigation will hold good. They further explained that out of the 24,000 KW about 10 to 12,000 KW was intended for irrigation (lift) and the rest for other industries like cement etc.

(iv) When earliest would the water from the Koyna storage under construction be made available to Mysore ?

(v) Whether Bombay Government had any proposal for construction of an anicut (weir) between the Koyna dam and the borders of the Bombay-Mysore States on Krishna.

(vi) They requested for a copy of the October 1956 Project Report of the Koyna Project.

3. The following clarifications were given during the discussions:—

(i) This will be supplied within the next two or three days.

(ii) It was clarified by the Bombay Engineers that it has all along been assumed that the cost would be shared between power and irrigation on a pro-rata basis as indicated in January 1952 Report. The Mysore Engineers have referred to Bombay Government's letter No. GKP 1151-K dated the 21st September 1951 printed in the 1952 Report as Appendix I and wanted evidence that the Planning Commission had allotted priority for the use of Koyna waters for power (by diversion) over irrigation. They further contended that in case 67,500 m.c.ft. of water should be allocated in all years (not admitted by Mysore Engineers for the present), the pro-rata charges of the capital cost should be on the basis of the quantities of designed utilisation. The Mysore Engineers also contended that in lean years the deficiencies should be shared by power and irrigation in the proportion of the designed storages.

It was stated by the Bombay Engineers that the Bombay Government was perfectly free to assign priorities within their allocated share of water and it had been decided by Bombay Government to accord the first priority to power, and that Koyna had been conceived primarily as a power Project and the irrigation benefits being secondary, the water supply for irrigation could not be expected to be given the same degree of reliability as that for power. It was further explained that the cost of Koyna water per Mcft. on pro-rata basis was very attractive when compared to costs of other irrigation storage projects.

(iii) It was indicated that it will not be possible to spare this power as Bombay is already seriously short of power in the 1st stage development of the Koyna project. As regards the rate of power, the question would not normally therefore arise. However it was clarified that the rate would be much higher.

(iv) This would depend on how the question of sharing of the storages would be decided. As programmed today the supplies may become available after 1962 at the earliest. If the Mysore storages would be wanted at a later date there will have to be a gap of at least 10 years after the completion of the present stage dam.

(v) There is no such proposal for the present. It was clarified that should such an anicut be constructed the water stored for Mysore will be delivered downstream of the anicut.

(vi) This was supplied to both the Chief Engineers.

4. Bombay Engineers supplied statements of run offs in the worst 25 years on record from 1829 to 1957. The statement also gave figures of surplus supplies available at the Koyna dam after meeting Bombay's requirements for power and irrigation as now under contemplation. A copy of this statement is attached herewith.

5. Mysore Engineers referred to Government's letter (Confidential) No. GKP 6558-N dated 14th May 1958 and said that they thought that 25,00 Mcft. of storage would be available every year. It was clarified by Bombay Engineers that what 25,000 meant was the maximum storage capacity of 25,000 Mcft. which could be provided in the dam (i.e. 98,000—73,000). The basis of the 40,000 Mcft. of storage for irrigation provided by Bombay was explained, and they were told that it was upto the Mysore Engineers to plan their irrigation in any manner they liked on the basis of the 25,000 Mcft. storage capacity provided, depending upon factors like the extent of shortages they would bear and at what frequency etc. It

was pointed out to them that the figures in the Statement of runoffs etc. referred to above would help them in planning utilisation.

6. The Mysore Engineers mentioned that unless power is made available and that too at the very cheap rate of 0.1 anna per K.W.H., the chances of lift irrigation under contemplation by them were pretty thin. The lift irrigation they had in view was the same as investigated by Shri Champhekar in his Report of 1951.

(ii) It was also stated by Mysore Engineers that it may be quite possible to take up Lift Irrigation in that area at higher rates by subsidising the rates if necessary, and that the whole question would be further examined in a detailed manner.

7. The Mysore Engineers also mentioned that they had under consideration the Upper Krishna Irrigation Project with the storage site at Sultanpur near Nalatwad. They mentioned that if water could be stored at the Koyna dam for this project, the storage at Sultanpur could be reduced proportionately. Bombay Engineers pointed out that this proposal would put an entirely different aspect on the subject under discussion as it has all along been thought that these waters were to be used entirely for the benefit of Bijapur Distt. for which no other source was possible, and not elsewhere. Such a proposal (viz., the storage at Sultanpur) could hardly be considered by Bombay Government as entitled to sharing the storage at Koyna dam.

(ii) The Mysore Engineers stated that the Upper Krishna Project benefited also the Bijapur Distt. The Bombay Engineers clarified that the above project not being an ex-Bombay State Project was not relevant to the discussion.

8. Shri Mathrani requested for a time schedule to be fixed for the supply of information by Bombay and a firm reply by Mysore indicating whether they would want the storage or not and if so when, so that the progress of construction of the Koyna dam will not be jeopardised. It was agreed that the Bombay Engineers would supply the information within a week and the Mysore Engineers would arrange to send their firm reply within 3 weeks thereafter.

9. After the receipt of reply by Bombay a further meeting should be arranged, if required.

Probable annual yield available beyond the requirements of Bombay State in 25 years of lowest rainfall.

S. No.	Year	Annual yield TMC. ft.	Yield available beyond the requirements of Bombay State T.M.C. ft.	Remarks
(1)	(2)	(3)	(4)	(5)
1	1899	53.6	0	
2	1918	63.7	0	
3	1877	90.5	3.5	
4	1951	92.2	5.2	
5	1941	93.8	6.8	
6	1838	96.3	9.3	
7	1809	96.3	9.3	
8	1931	99.0	12.0	
9	1949	99.0	12.0	
10	1880	100.6	13.6	
11	1902	101.5	14.5	
12	1948	102.3	15.3	
13	1911	104.0	17.0	
14	1950	104.0	17.0	
15	1952	104.0	17.0	
16	1871	104.8	17.8	
17	1935	104.8	17.8	
18	1929	106.5	19.5	
19	1905	113.2	26.2	
20	1947	113.2	26.2	
21	1906	114.0	27.0	
22	1859	114.8	28.8	
23	1867	114.8	27.8	
24	1925	115.6	28.6	
25	1904	119.6	32.6	

NOTE :—Total requirements for Bombay State are :
 67.5 T.M. Cft. for power
 16.0 T.M. Cft. for irrigation
 3.5 T.M. Cft. for evaporation losses.
 87.0 T.M. Cft. Total.

APPENDIX IV-A

M.P. MATHRANI,

Member, Irrigation & Power Team.

D. O. No. COPP/I&P/MP/5
Committee on Plan Projects,
'Krishi Bhavan'
Queen Victoria Road,
New Delhi.

Dated August 21, 1958.

My dear Murti,

I am enclosing herewith a note on the likely output of concreting of the Dam by two cableways at Koyna for your information and comments. I am inclined to be of the view that the present cableway capacity of 30 ton will not be adequate for supplying power in the monsoon season of 1961 which appears to be the target at present against the previous target of monsoon of 1960. The progress may even be slightly less than what has been assumed in the note because of difficulty of time taken in laying rubble but it would still be possible to bring up the Dam to a level by May 1961 to give enough water for working one Turbine.

Yours sincerely,

Sd/- M. P. MATHRANI.

Shri N. G. K. Murti, I. S. E.,
Chief Engineer, Koyna Project,
P. O. Koyna Nagar, Bombay State.

Encl. : As above.

A note on the likely output of concreting of the Dam by the cableways at Koyna.

The total quantity of rubble concrete and other plain concrete in the tender seems to be about 31.3 M.c.ft. The quantity of such concrete provided in October 1956 estimate is 36.4 M.c.ft. Due to the changes proposed to be made in the concrete section both in foundation and superstructure for the storage of 73,000 M.c.ft. required by Bombay is still the same, i.e., about 36.4 M.c.ft. It is not quite

clear how the figure of 31·3 M.c.ft. came to be provided in the original tender. It, however, appears that at the time of finalising the tender, the contractor was aware that the quantity will be about 36·4 M.c.ft. and the construction schedules are apparently made on that basis. The completion date provided in the tender for concreting of the Dam is 30th April, 1960. It is not quite clear whether the contractors will be entitled to any extra period for additional quantity.

2. The contract was sanctioned by middle of March, 1956 and the concreting work of the Dam was started on 1st March, 1958. The progress since then has been as under:—

(1) March	0·12 M.c. ft.
(2) April	0·20 „
(3) May	0·13 „
(4) June	0·16 „
<hr/>	
TOTAL ..	0·61 M.c. ft.
<hr/>	

The work has since been stopped due to the monsoon season. It will be seen that the quantity of concrete done during the first working season has been insignificant. According to the terms of the contract there will be only two working seasons left up to April 1960, i.e., only 15 working months. On the basis of the quantities shown in the tender the average monthly progress will have to be about 2 M.c.ft. and on the basis of the quantities actually to be done, it will have to be about 2·4 M.c.ft. per month. It appears that it will not be possible to attain this programme on the basis of the existing cable capacity.

3. The date of completion for supply of power has now been extended from October 1960 to April 1961. This would mean that there will be 23 working months. On the basis of the tender quantity the progress required will be 1·35 M.c.ft. per month and on the basis of the estimated quantities it will have to be about 1·6 M.c.ft. per month. It is very doubtful if even an average output of 1·35 M.c.ft. per month can be obtained from the two cableways provided for placing concrete.

4. In this connection study has been made of the progress given by the cableways at Rihand. The Rihand Dam is an all concrete Dam with about 60 M.c.ft. of concrete to do. The work of concrete was started in April 1957 and the target date of completion is June 1961. It is thus scheduled to be completed in about 4 1/2 working

seasons. In each season there will be possibly nine working months. Therefore, the total number of working months scheduled is about 39 months and the average progress per working month required would be about $60/39=1.5$ M.c.ft. approximately. The plant for placing concrete as actually provided is as follows:

April 1957 to August 1957—One 10 ton cableway

October 1957 to June 1958—Two 10 ton and one 20 ton cable.

February 1958 onwards—Two 10 ton cables and two 20 ton cables.

5. The production performance of the concreting is as tabulated in the accompanying statement. It is seen therefrom that the cumulative average monthly production per 10 ton installed capacity of cable has been of the order of about 0.25 M.c.ft. whereas the rated capacity is about 0.5 M.c.ft. per month. Reference in this connection may be invited to an article on Rihand Dam appearing in Bhagirath of November 1957 and annexure to this note.

6. It will be seen from the statement that the production efficiency for individual months as well as average is in the neighbourhood of 50%, this being the first working season for all the cableways. It is presumed that the ultimate average efficiency may go up to 60% in which case the monthly output of 10 ton cableway capacity will be $0.6 \times 0.5 = 0.3$ M.c.ft.

7. It may be mentioned that in Koyna, it is not a straightforward concrete but it is rubble concrete, which will take longer time in laying and the output may even be somewhat less. Projecting the Rihand results to Koyna Project, where the length of the Dam is comparable to that of Rihand, the ultimate monthly production for a 30 ton installed cable capacity would be $3 \times 0.3 = 0.9$ M.c.ft. assuming:—

(a) That steps would be taken to make full use of both the cables, as at present one cable is used for concrete and one for rubble. The ratio of concrete to rubble is 60:40. The cable for rubble will have to be used partly for concrete also by modifying the bucket design.

(b) The bottleneck of spreading rubble is overcome by laying concrete in more than one monolith at a time.

8. From annexure-I it will be seen that the actual travel time for the cycle will not be less than six minutes at full efficiency. Therefore, the production expected from the present cableway capacity would be as follows for various seasons. It is assumed that it will

take 4 months from October 1958 to January 1959 to attain the full capacity of 0.9 M.c.ft. The average for these 4 months has been taken as 0.67 M.c.ft.

Period	Months	Monthly Production with 2 cables	Production (M.C. Ft.)	
			During the period	Total
March '58—May '58	..	—	0.6	0.6
Oct. '58—Jan. '59	4	2.7	3.3
Feb. '59—May '59	..	4	3.6	6.9
Oct. '59—May '60	8	7.2	14.1
Oct. '60—May '61	8	7.2	21.3
Oct. '61—May '62	..	8	7.2	28.5
Oct. '62—May '63	8	7.2	35.7

This means, it would only be after monsoon of 1962, when the minimum of 30 M.c.ft. of concreting is done, that 1st unit would be tested and operated as against October 1960 as intended previously and now revised to April 1961. The first stage concrete will be completed by May 1963 as against April 1961 now proposed.

9. It would, therefore, seem to be essential to augment the cable capacity by another 20 ton cables so that it will add about 0.6 M.c.ft. per month or 4.8 M.c.ft. per season. It is seen from the following table that it will be then just possible to test the 1st unit by 1961 monsoon and complete the dam by end of 1961 provided the additional cable capacity is installed by beginning of April 1959. If there is any further delay in the installation of the additional cable capacity the final date will be further postponed.

Period	Total concreting with 2 cables	Concrete by 3rd cable proposed at 0.6 Mcft/Mth during the period starting April '59 (M.C.Ft.)	Total concrete by 3rd cable by end of the period. (M.C.Ft.)	Total concrete by all 3 cables (2)+(3) (M.C.Ft)
1	2	3	4	5
Upto May '59	6.9	1.2	1.2	8.1
Oct. '59—May '60	14.1	4.8	6.0	20.1
Oct. '60—May '61	21.3	4.8	10.8	32.1
Oct. '61—Dec. '61	24.0	1.8	12.6	36.6

10. After completion of the concrete, installation of crest gates, roadway, etc. will take about ten months more which will bring the completion of the dam to October 1962 against 31st March 1961 provided in the tender. This will be the position even after the installation of additional cable capacity. This matter, therefore, deserves serious attention of the project authorities.

ANNEXURE-1

The rated output of Rihand concreting plant is quoted as 120,000 c.ft./day (*vide* article on Rihand Project, in Bhagirath of November, 1957). The concreting cables installed are of 60T capacity (2 of 10T and 2 of 20T), carrying 24 cyd. or 648 c.ft. per cycle.

$$\begin{aligned}
 \text{Av. No. of cycles/day} & \dots \dots = \frac{120,000}{648} = 185 \cdot 5 \\
 \therefore \text{Av. cycle time} & \dots = \frac{22 \times 60}{185 \cdot 5} = 7 \cdot 1 \text{ mts. (allowing 2 hours for servicing of plant).} \\
 \therefore \text{Actual individual cycle time at 80\% efficiency} & \dots \dots = 7 \cdot 1 \times 0 \cdot 8 = 5 \cdot 68 \text{ say 6 mts.}
 \end{aligned}$$

which is quite reasonable and tallies with that observed at Koyna, where the individual cycle time was about 6 minutes (excluding time taken at concreting spot).

2. On the basis of speeds, time taken per cycle works out as under:

$$\begin{aligned}
 & \text{Length of cable way} \dots \dots = 2800 \text{ approximate} \\
 \therefore & \text{Average travel length of cycle both ways} = 2 \times 1/2 \cdot 2800 = 2800 \text{ft} \\
 & \text{Travel speed} = 6 \text{ meter/sec.} \\
 \text{(i) } \therefore & \text{Time for travel /Av. cycle} \dots \dots = \frac{2800}{6 \times 3 \cdot 3} = 140 \text{ sec.} \\
 & \text{Vertical lift/cycle} = 200 + 100 \dots \dots = 300 \text{ ft.} \\
 \text{(ii) } \therefore & \text{Time for lifting buckets at 1 meter/sec.} = \frac{300}{3 \cdot 3} = 90 \text{ sec.} \\
 \text{(iii) and time for lowering buckets at} & \dots \dots = \frac{300}{6 \cdot 6} = 45 \text{ sec.} \\
 & \text{2 meters/sec.} \dots \dots \\
 \text{(iv) Time for spotting and emptying concrete} & \dots \dots = 45 \text{ sec.} \\
 \text{(v) Time for filling concrete} & \dots \dots = 30 \text{ sec.} \\
 \text{Total} & \dots \dots = 350 \text{ sec.} \\
 & \text{Say 6 minutes.}
 \end{aligned}$$

Rated capacity for 60T rig
 = 120,000 cft. per day.
 Rated capacity for 10T rig
 = 20,000 cft. per day.
 Rated capacity for 10T/rig/month
 = 25 X 20,000 = 5 L. cft.

Month	No. of cables installed		Installed capacity of cables.		Monthly output in lac cft. (6)	Cumulative output in lac cft. (7)	Monthly Production per 10T installed capacity		Efficiency %	
	10T (2)	20T (3)	For the month (4)	Cumulation up to end of month. (5)			Individual (8)	Average (9)	Monthly (10)	Average (11)
April 1957 ..	1	—	10	—	0.45	—	—	—	—	First month is ignored.
May 1957 ..	1	—	10	10	2.83	2.83	2.83	2.83	57	57
June 1957 ..	1	—	10	20	3.62	6.45	3.62	3.22	74	64
July 1957 ..	1	—	10	—	2.60	—	—	—	—	These monsoon months are ignored.
Aug. 1957 ..	1	—	10	—	1.57	—	—	—	—	—
Sept. 1957 ..	2	1	40	—	—	—	—	—	—	—
Oct. 1957 ..	2	1	40	—	2.62	—	—	—	—	—
Nov. 1957 ..	2	1	40	60	7.75	14.20	1.54	2.37	31	47
Dec. 1957 ..	2	1	40	100	9.21	23.41	2.30	2.34	46	47
Jan. 1958 ..	2	1	40	140	12.12	35.53	3.03	2.54	61	51
Feb. 1958 ..	2	2	60	200	13.79	49.32	2.30	2.46	46	49
March 1958 ..	2	2	60	260	13.96	63.28	2.33	2.43	47	49
April 1958 ..	2	2	60	320	16.96	80.24	2.83	2.51	57	50
May 1958 ..	2	2	60	380	17.23	97.47	2.87	2.57	58	51
June 1958 ..	2	2	60	440	—	—	—	—	—	—

N. G.K. MURTI, I.S.E.,
Chief Engineer, Koyna.

D.O.No.C-1/-396-T
Office of the Chief Engineer, Koyna,
P. O. Koyna, Via Karad, Dist. N. Satara.
24th September, 1958.

Dear Mathrani,

Subject.—Programme of concreting the Dam—output by cableways.

Reference—Your D. O. No. COPP/I&P/MP 4496 dated 21-8-1958.

It is very kind of you to supply such very useful information with regard to what has been achieved so far on the Rihand Dam. By assessing our contractors performance by what has been so far achieved on the Rihand Dam, PRO-RATA to the capacity of the cable cranes, it has to be conceded that the performance will be as indicated in the table appearing on page 4 of your note. But I do not desire just now, to either accept this performance table or assert that it would be possible for our contractors to show a much better performance more in accordance with the rated capacity of the cable cranes and with their own programme.

2. Actually I have already written to our contractors in sufficient details explaining to them the difficult position in which they are placed and steps that they should take for reaching as near the rated capacity of placement as possible. They have already taken steps to remove some of the problems that have appeared in their production line of the aggregates during the three months' experience before monsoon.

3. It will please be seen that in these first three months of the concreting, they have laid about 0.65 m.c.ft. of concrete, which is almost equal to the first three months performance at Rihand Dam. In either case one cable crane was in operation.

4. The reasons why we have been expecting higher performance in placement of concrete despite rubble concrete are as under (if compared with the performance at Rihand) :

- (a) The span of our cable crane is about 2,500 ft. as against the span of the 20 tons cable crane on Rihand being 3,500 or 3,600 ft. In other words the length of travel in the case of Rihand is 33% to 40% more than ours.
- (b) If I remember right the 10 Ton cable crane at Rihand do not have the same span which makes concrete go a longer way to feed smaller cable cranes. The simultaneous operation of many cable ways, you will agree, would be more interfering and complicated than fewer cable ways of bigger capacity for a given work.
- (c) We have mixers for 9 c.yds. capacity (3 Nos. of 3 c. yds. each) as against Rihand capacity of 16 c.yds. (4 Nos. of 4 c.yds. each). Ours being rubble concrete (assuming even 66 c.ft. concrete in 100 cft. of rubble concrete) our mixer capacity (installed) would be $1\frac{1}{2}$ times installed capacity per 100 c.ft. of dam *i.e.* more than 13.5 c.yds. Comparatively at Rihand they have to lay nearly twice our amount of concrete, more or less in the same time. Thus for 100 c.ft. conventional concrete in their case for the same speed they have got only 8 c.yds. against our 13.5 c. yds. Consequently we believe that there will be less loss of time on account of feeding the cable cranes from the mixer and therefore more cycles per hour can be attained from our cable cranes than at Rihand.
- (d) In the normal conventional concrete, placement is more or less confined to one monolith at a time. In our case on account of rubble concrete and also with a view to increase the speed of placement the Contractors have been advised to place concrete atleast in two monoliths if not in three simultaneously, so that the full capacity of the crane is exploited. Such simultaneous placement will only increase form work which can be arranged for in an easier and quicker manner than crane machinery.

5. The above reasons can easily be computed to show more than 50% better performance than at Rihand (*i.e.*) more than $\frac{3}{2} \times 0.9 = 1.35$ m.cft. per month. Even so, I have been formulating in my mind a programme of atleast $1\frac{1}{4}$ m.cft. per month from our installation. This does not mean that we have not already cautioned our contractors of this possible bottleneck with the conveyance mechanism. They have already been advised to be seriously seized of this problem and be prepared for augmenting the placement machinery in a manner

which is most suitable to them. It is, but, fair to leave the choice to them. An extra cable crane will be more complicated in the present set up on account of interference and restriction of moving space for the tail masts.

6. Giving consideration to the various difficulties, we anticipate that they may show a performance as under:—

Year	Placement during the year in M.C.ft.	Progressive total in M.C. ft.
(1)	(2)	(3)
1957-58	0.65	0.65
1958-59 October, November & December ..	$(0.5 + 1.0 + 1.25) = 2.75$	9.65
1958-59 January to May ..	$(5 + 1.25) = 6.25$	
1959-60	$(8 + 1.15) = 10.00$	19.65
1960-61	10.00	29.65
1961-62	8.00 or more up to 10.00	36.4 or 39.65

It will thus be seen by 1962 May it will be possible to store nearly full quota of water for power (Stage I) without the gates and also to store adequate water in 1961 monsoon for running one machine in July-August and second one in November-December or so and third some time in April 1962.

7. With regard to the cycle of operation if we place concrete in 2 or more monoliths at a time, and with the given capacity of the mixers, we have also worked out after allowing various inefficiencies in handling a 6 minute cycle. *i.e.* 10 cycles an hour. Assuming 20 working hours only a day we should aim at 200 cycles per day *i.e.* 2,400 c. yds. a day or 64,800 c. ft. a day. I agree that we cannot expect this as an average per day for the whole season. We may only work upto 75% efficiency (10% due to loss of time and 15% due to less rubble compared to concrete). In other words 48,600 c.ft. can be laid per day or say 50,000 c.ft. The contractors have already been planning to take only one day off after 13 working days as holiday. Even so we may assume only 25 instead of 28 days of working per month. This would give $(25 \times 50,000)$ 1 1/4 m.cft. per month. This was our counter check against performance table given in the foregoing paragraph.

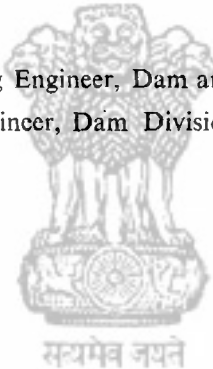
8. The Indian Directors of the Contractors are now proceeding abroad and they would be returning before the middle of October.

Yours sincerely,

Copy forwarded to:

1 The Superintendent

1. The Superintending Engineer, Dam and Designs Circle, Koyna.



M. P. MATHRANI,

Member, Irrigation & Power Team.

D.O. No. COPP/I&P/MP/34
Committee on Plan Projects
Krishi Bhavan, New Delhi.

Dated September 25, 1958.

My dear Murti,

Subject.—Programme of concreting the Dam output by cableways.

I am in receipt of your D. O. letter No. C-1/396-T dated 24th September, 1958 and thank you for the same. I am enclosing herewith a note on the working of the cableways at Rihand, about which I spoke to you at Bombay, for your information. As you will see from this note, the span of the two cableways of 20 tons each is 3,000 ft. and that of 10 tons 2,100 ft. and the average will not be more than the length of your span.

2. I do not think the capacity of the concrete mixers is in any way a bottleneck at Rihand or will be a bottleneck in your case. The capacity seems to be quite ample at both places. As you will see from their note that they are allowing for an average output of about 80,000 cu. ft. per day or about 20,00,000 per month. As far as I know they are also attempting to cut down the non-working days as far as possible. Therefore, on the basis of Rihand experience your output should be 40,000 cu. ft. per day if you were doing plain concrete but as you will be doing rubble concrete the rubble cable will probably not give the full output.

3. I note that you propose to wait till December next to see how to accelerate the performance of the contractors in laying concrete. I feel doubtful if the performance within next two or three months will yield any useful results to judge whether they can reach an output of 1.25 million cu. ft. per month. Even according to your programme you will be finishing 29.65 million cu. ft. of concrete by May 1961. If you fall short of a million or two million cu. ft. even, I doubt if there will be any storage for working one turbine.

4. I would like to thank you very much for your kindness in giving us time and looking after us so well when we were at Bombay.

Yours sincerely,

Sd/- M. P. MATHRANI.

Shri N. G. K. Murti, I. S.E.,
Chief Engineer, Koyna Project, Bombay.

APPENDIX IV-B

M. P. MATHRANI,

Member, Irrigation & Power Team.

D.O. No. COPP/I&P/MP/6
Committee on Plan Projects,
'Krishi Bhavan' New Delhi.

Dated August 13, 1958.

My dear Murti,

I am enclosing herewith a note on the programme for the Pressure Shaft and I would request you to throw light on the various points in that note.

2. It appears to me that the Pressure Shaft may be a bottleneck in the completion of the work and generation of energy in April 1961.

Yours sincerely,

Sd/- M. P. MATHRANI.

Shri N. G. K. Murti, I. S.E.,
Chief Engineer, Koyna Project,
P. O. Koyna Nagar, Bombay State.
Encl : As above.



A note on construction programme of Pressure Shaft.

According to the original schedule of construction (1956 October Report) the underground excavation of the Pressure Shaft was scheduled to start in November 1956. It was actually started in November 1957. It was originally scheduled to be completed in April 1959 and in the first revised schedule, it was to be completed in December 1958, and according to the second revised schedule, excavation of Shaft No. 1 is expected to be completed by March 1959 and that of Shaft No. 2 by November 1959. The progress of excavation in Shaft No. 1 up to June 1958 is 320 ft. The total length of each Shaft is about 2,020 ft. The excavation remaining is thus $2,020 - 320 = 1700$ ft. The optimum output of excavation from the two heads expected is about 150 ft. per month. The excavation is going from the bottom at both the heads and every time the blasting

is done, all service connections like ventilation pipes, compressed air pipes, etc. have to be removed and as the excavation proceeds upward the fitting and removal of such services will take longer time. On the basis of the optimum monthly progress of 150 ft., the time required for the remaining length of 1,700 ft. will be about 12 months. The excavation of Shaft No. 1 will thus be completed by about June-July 1959 against March 1959 shown in the second revised schedule. Concreting of Pressure Shaft No. 1 is expected to start by October 1959 and to be completed by November 1960. Grouting and testing will take some more months which will bring the completion date of Shaft No. 1 to March 1961 against March 1960 provided in the tender.

2. It will be seen that there is going to be delay of about 5 months or so in completion of excavation against the second revised schedule target. This will correspondingly delay the starting of the work of steel lining and concreting. It was understood that the excavation work of Shaft No. 1 is proposed to be taken from the top also from the emergency valve tunnel side. The work from the top going down will, no doubt, be difficult but there appears to be an urgent necessity for doing it.

3. The work of steel lining has, of course, not yet been started but it is seen from the programme that it will be started in October 1959 and completed in November 1960 with a gap of 4 monsoon months in which no work is provided to be done. There will thus be 10 months left for completion of the steel lining and concreting. This would mean that the length of about 200 ft. of steel lining will have to be done every month. The length of each pipe is to be restricted to about 15 ft. It would thus mean that a pipe has to be laid and concreted every alternate day. This appears to be a very tight programme. The programme proposed to be followed for steel lining in the Pressure Shaft and at other places like surge, head race tunnel, etc. may kindly be indicated in detail.

4. The work of steel lining will require very expert supervision, as no such work of this kind has been done by the staff engaged in the Organisation. It would, therefore, seem to be necessary to employ an expert supervisor probably from abroad for supervising the work on behalf of the Government. It may please be intimated if the Organisation is contemplating to get any such expert through the Swiss Firm of Consultants.

N. G. K. MURTI, I.S.E.,
Chief Engineer, Koyna.

D.O. No. 399 T
Office of the Chief Engineer, Koyna,
P. O. Koyna, Via Karad, Dist. N. Satara
24th September 1958.

Sub.—Programme of pressure shafts—excavation and steel lining.

Ref.—Your D.O. Letter No. COPP/I&P/MP/6 dated the 23rd August 1958.

Dear Mathrani,

I am unable to reply to your letter even now because the note is based on:—

- (a) Progress seen in the starting months of the excavation of the shafts.
- (b) No practical experience about the speed of installing pipes in the pressure shafts.

2. With regard to the excavation the contractors (M/s Hindustan Construction Co.) have gone abroad to Italy and Sweden for studying the methods adopted in those countries for a very much speedier excavation of the pressure shafts. It seems that they are also bringing with them some Italian, foreman who would handle the job of excavation. They are expected back in the middle of October and thereafter only I can say something more definite.

3. With regard to the steel lining we have to depend entirely upon our consultants whose partners are the consultants to the Contractors M/s Indian Hume Pipe Co. They are going to lend Swiss personnel for this job of fabricating and installing the pipes. As the contractors collaborators and consultants are the same, they already know all our target dates and the site conditions more realistically than any other foreign consultant or collaborators. That is why we expect that they will do the work in time.

4. The Director of the Indian Hume Pipe Co. has gone abroad for getting necessary planning drawn up. He is expected to return in the middle of October. After he returns I can discuss with him about the programme and give you a suitable reply of what may actually happen on our project.

Yours sincerely,

Sd.- N. G. K. MURTI.

Shri M. P. Mathrani, I.S.E.,
Chief Engineer,
Member, Irrigation and Power Team,

APPENDIX V

**Shri Kirloskar's Proposal for constructing the Koyna Dam to full height, right in the first stage*

In accordance with the Board's decision at the 11th meeting held on the 10th June 1955, the Chief Engineer, Koyna has forwarded a note discussing the implications of Shri Kirloskar's proposal for constructing the Koyna Dam to full height, right in the first stage. The Chief Engineer (Electrical), Koyna, has forwarded a note on the likely growth of electric load in the area to be served by the Koyna Project (copies of the notes are appended.)

2. The Chief Engineer, Koyna is of the view that unless, there is going to be a gap of 10 years between the end of 1st stage of dam construction and the beginning of the 2nd stage, and unless this is justified by strong economic reasons, it would not be worth while to construct the dam in two stages as envisaged at present. In paragraph 5 of his note the Chief Engineer, Koyna has indicated how the construction of the dam can be phased. Of the five alternatives discussed in that paragraph, the Chief Engineer recommends alternative (d). In his opinion building the dam of full height straight away seems to be the best proposition, if the necessary money can be obtained and if justified by the expected growth of load in the area served by the Koyna Project.

3. The Chief Engineer, Koyna has pointed out in paragraph 8 of his note that by adopting the final section of the dam right from the beginning, there will be no change in the target date for starting the first machine in October 1960. The net effect of adopting the full section will be to continue the construction period by 2 years.

4. The Chief Engineer (Electrical), Koyna, in his note on the likely growth of load in the area served by the Koyna Project states that the power generated by the 1st stage of the Koyna Project would be fully consumed by 1968-69 or thereabouts. This forecast, he points out, does not take into consideration load growth in the eastern part of the State like Sholapur, Pandharpur, etc., and that if these are to be supplied in the Second Five Year Plan, another 50 M. W. will be needed from the Koyna Power House by 1966-67.

5. The Cabinet Sub-Committee which recently examined the schemes proposed to be included in the Second Five Year Plan has recommended that the extension of Koyna scheme to Sholapur estimated to cost Rs. 13 crores should be taken up in the Second Five Year

*Item VII of agenda for 12th meeting of Koyna Control Board (4-8-55).

Plan and accordingly this scheme is being included in the list of schemes to be forwarded to the Planning Commission for its approval.

6. For the reasons discussed above it is for the consideration of the Board whether the final section of the Koyna dam should be adopted right from the beginning and whether the alternative (d) in paragraph 5 of the Chief Engineer, Koyna's note should be accepted.

OFFICE OF THE CHIEF ENGINEER, KOYNA,
MERCANTILE BANK BUILDING, 4TH FLOOR
BOMBAY 1 : 4TH JULY 1955.

Note on Shri Kirloskar's proposal for constructing the Koyna Dam to full height, right in the 1st stage

Reference—Government Memorandum No K. C. B. 1055 N, dated 17th June 1955.

2. The proposals were discussed in the 11th meeting of the Koyna Control Board held on 10th June 1955, when the Chief Engineer (Koyna) was asked to submit a note discussing the implications of the proposals.

3. One of the factors pertinent to this discussion is the likely growth of electric load in the area served by the Koyna project and how soon the additional firm power supplied by the first stage of Koyna will be consumed. This note does not deal with that aspect. The Chief Engineer (Electrical) Koyna is being requested to deal with this aspect.

However it can be stated as a general proposition that unless there is going to be a gap of 10 years between the end of 1st stage of dam construction and the beginning of the 2nd stage it would not be worthwhile to construct the dam in two stages as proposed. Because constructing the dam in two stages, with a leaner than the final section in the first stage, involves a joint of old and new work in the vertical direction, which is a tricky engineering job and leaves a doubt as to the homogeneity and soundness of the final dam section. Unless justified by strong economic reasons, no engineer would like to get involved in such a situation.

4. This note deals with the extra cost involved in building a higher or thicker dam than contemplated in the project administratively approved. In considering these costs, the dam contemplated in the sanctioned project is in masonry at flanks and cement concrete in the central portion.

5. The construction of the dam can be phased as follows:—

- (a) Dam of leaner section in flanks and full section in the centre and upto R.L. 2107.5. Foundations to be dug for the full section required in 2nd stage.

This is what is provided in the sanctioned project. Cost Rs. 8.38 crores.

- (b) Dam of full second stage section upto ground level, above ground as in (a) above cost Rs. 9.32 crores.

Excess over (a) Rs. 0.94 crores.

- (c) Dam of full second stage section but upto 1st stage height *i. e.* upto R.L. 2107.5

Cost Rs. 10.24 crores.

Excess over (a) Rs. 1.86 crores.

- (d) Cost of full second stage dam upto R.L. 2171 constructed at one stretch.

Rs. 11.52 crores.

Excess over (a) Rs. 3.14 crores.

If the gates are postponed till actually required for irrigation, this amount can be reduced by Rs. 0.25 crores to Rs. 2.89 crores. If gates are omitted water will be held to R.L. 2130.0, for which water contents are 68,000 million cubic feet gross.

- (e) Ultimate cost of dam of leaner section as in (a) in first stage and then completed to full height and section in 2nd stage will be Rs. 12.75 crores.

This allows Rs. 0.50 crores for treatment of joint between old and new masonry and Rs. 0.50 crores for new buildings and repairs of roads, 0.23 crores for raising gates and gatebridge, new set up of machinery etc.

6. Out of the phase enumerated above (b) need not be considered as it still leaves the complication of the joint between old and new mass. So if at all we want to avoid this complication, we have to adopt (c) or (d). (c) will be ultimately costlier than (d) by Rs. 0.73 crores.

7. (d) *i.e.* building the Koyna dam of full height straightaway seems to be the best proposition, if the necessary money can be obtained and if justified by the expected growth of load in the area served by the Koyna Project.

8. Another point which requires consideration in this connection is whether by adopting the final section of the dam right from the beginning is likely to postpone the target date for starting the first

Sd/-

Chief Engineer, Koyna.

Note on Shri Kirloskar's proposal for constructing the Koyna Dam to full height, right in the first stage—Load forecast for Project

Reference—Note of Chief Engineer (Koyna) dated 4th July, 1955.

The load forecast for the Bombay-Poona area as indicated in the statement I attached, shows that the increase in load of the order of about 17 MW per year. The present peak demand is about 320 MW against the forecast of 353 in 1955. The difference is ascribed to the restrictions of staggering etc. The total firm power capacity of the system when all the 3 steam power sets of Bombay Electricity Board Chola Plant are on full load would be 336 MW. After the first Trombay set is put into commission by the end of 1956 the firm capacity would be 386 MW. There is a provision of an additional 12.5 MW from the Trombay set by increasing the pressure of the cooling gas. When two Trombay sets are commissioned in 1957 it would be 408 MW plus 12.5 MW available when pressure of cooling gas is increased. This firm capacity would be adequate to meet the demands till 1958. There will be some shortage between 1958 and 1960, unless the Central Railway have been permitted to instal their 18 MW set. When the first 4 sets of the Koyna Project are commissioned in 1961-62, the firm power capacity for Bombay-Poona area will be about 628 MW. This will be adequate to meet all the demands till 1970.

But if any extra loads other than the normal growth of 17 MW per year are to come up the position will be as follows:—

The extra loads so far as we are aware of now are Railway 40 MW, Naval Dockyard 15 MW, and Atomic energy 18 MW of these the Railways expect say about 25 MW by 1958-59 and the others by 1960—63. If this total of 73 MW is after 1963 the total demand will be 580 MW and therefore it will be within the capacity of the interconnected system. The limit will however be reached sometime in 1967-68, (taking into consideration the higher load capacity (625 MW) of the Trombay sets).

It is not known whether the Railways will instal the 18 MW set for which they have been making arrangements and whether they will rehabilitate the old sets of an aggregate of 40 MW. If the 18 MW set is installed say, by 1958-59, the firm capacity of the system will be 646 MW. If the higher loading capacity of the Trombay sets is taken into account, the firm power will be 668 MW and will last till 1968-69.

Thus it will be seen that Koyna first stage would be fully consumed by 1968-69 or thereabouts on the basis of the load forecasts and the extra special loads mentioned above.

This does not take into consideration load growth in the eastern part of the state like Sholapur, Pandharpur, etc. If these areas are to be supplied in the Second Five Year Plan another 50 MW will be needed from the Koyna Power House by 1966-67.

STATEMENT I

Power requirements of Bombay-Poona area as estimated (during 1953 & 1954).

<i>Year</i>						<i>Forecast by Bombay Government MW</i>
1955	..	..	..	..	..	353
1956	..	..	..	..	..	370
1957	..	..	..	..	..	392
1958	..	..	..	..	..	414
1959	..	..	..	..	..	437
1960	..	..	..	..	..	454
1961	..	..	..	..	..	472
1962	..	..	..	..	..	490
1963	..	..	..	..	..	507
1964	..	..	..	..	..	524
1965	..	..	..	..	..	541
1966	..	..	..	..	..	558
1967	..	..	..	..	..	575
1968	..	..	..	..	..	592
1969	..	..	..	..	..	609
1970	..	..	..	..	..	626

The above load statement does not include the expected extra load of the Railway of 40 MW, of Naval Dockyard 15MW. and atomic energy— 18 MW, making a total of 73MW. If this is added, the loads from 1963—1970 will increase by 73 MW in each case.

APPENDIX VI

M.P. MATHRANI,

Member, Irrigation and Power Team

D. O. No. COPP/I&P/MP/12
Committee on Plan Projects
Irrigation and Power Team
'Krishi Bhavan'

Queen Victoria Road,
New Delhi.

Dated August 28, 1958.

My dear Murti,

It has been ascertained that the difference in the cost of cement in bags and in bulk is about Rs. 13/- per ton. On this basis the saving in getting cement in bulk on 2,80,000 tons would have been about Rs. 36.4 lakhs. Besides, according to the terms of Dam contract a rebate of Rs. 2/5/- per ton has to be given to the contractor for loss in cement in transit coming in bags. This would mean a further loss of about Rs. 6.6 lakhs on 2,80,000 tons. The total extra expenditure in getting cement in bags will thus be about Rs. 43 lakhs. I doubt if the extra cost in making cement silos for storing cement at different places and other arrangements for conveying cement to site etc., would have cost so much extra amount. Probably the whole question was gone into. Could you kindly enlighten me on the same ?

2. In the statement of excesses and savings you have shown extra cost on cement of 2,80,000 tons as being Rs. 90 lakhs. This works out to about Rs. 32 per ton. I understand that the extra excise duty on cement after 15th March, 1956 that has to be paid is about Rs. 19 per ton. Is there any reason why the cement is costing an extra amount of Rs. 32 per ton ?

Yours sincerely,

Sd/- M.P. MATHRANI.

Shri N. G. K. Murti, I.S.E.,
Chief Engineer, Koyna Project,
P. O. Koyna Nagar, Bombay State

APPENDIX VII

Report of the Technical Sub-Committee appointed by the Koyna Control Board in their meeting of the 16th May, 1955.

The meeting of the above Sub-Committee was held in the office of the Chief Engineer, Koyna Project on 26th instant.

The following were present :—

Shri L. P. Bhargava, Member, Desisgns, Central Water and Power Commission.

Shri U. N. Mahida, Chief Engineer (Irrigation) Public Works Department.

Shri M. L. Champhekar, Chief Engineer, Koyna.

Shri W. X. Mascarenhas, Chief Engineer, Public Works Department (Roads and Buildings) *being out of station could not attend.*

Shri N. G. K. Murti, Superintending Engineer, Colonies, Karad, Shri P. R. Joshi, Personal Assistant to the Chief Engineer, Koyna, Shri B. G. Dholakia, Executive Engineer, Koyna, were present during the discussion.

After carefully considering the various points involved the following decisions were reached on the question referred to the Sub-Committee. The terms of reference to the Sub-Committee mentioned first and then the decisions taken by the Sub-Committee in reply to that term of reference are given.

I. First term of reference

Whether the Koyna Project should be executed through Contractors or departmentally.

The points to be considered are, whether we have *sufficient technical staff* and *sufficient labour* available. In case of masonry dam whether the large force of *masons about 1,600 at peak period will be available.*

I (a) The question as to whether the Koyna Project should be executed departmentally or by contract was considered in some detail.

It was felt that though carrying out the work departmentally would possibly be cheaper, the final decision to rule out work by contract, should be taken only after watching the results of the first set of tenders issued or being issued.

I (b) In the meantime the foundation excavation of the dam which is in progress should be carried on departmentally as at present and

the tempo of the work should not be slackened whatever decision is reached about the agency. If it is by contract, the work should be carried on till the contractor is ready to commence his operations and then the plant included in the tender conditions passed on to him.

I (c) Some extra machinery like Air-Compressors and Drills for the excavation in rock should be purchased and put on the job of foundation excavation in rock. The Koyna Control Board has already approved of the purchase of such machinery upto Rs. 5 lakh.

I (d) Machinery and equipment recommended to be purchased for tunnel excavation by the Chief Engineer (Koyna) in his note to the Control Board meeting of 15th April 1955 should be purchased. This equipment is of a general nature and is suitable for being used either on subsequent contracts for Koyna Works or on other Public Works Department works. In the meeting of 15th April 1955, the Koyna Control Board had not approved of the purchase of this Machinery. But it is advisable to purchase it.

I (e) Planning and inquiries for plant and equipment should be taken up in hand so as to be ready for placing orders if decision is taken to take up the work departmentally. In short the preparation should be brought to a stage just short of the actual purchase.

I (f) No appreciable shortage of technical personnel of labour is likely to be felt, if the execution of work is undertaken departmentally.

II. The second term of reference

Whether the dam should be constructed in masonry or concrete. Whether if masonry is adopted, the time schedule can be maintained.

II (a) The Koyna Dam by modern standards is not too high to preclude the use of masonry, and it is quite feasible to construct it in masonry subject to the following:—

- (i) The portions where stresses in masonry are in excess of 300 lbs p.s.i. should be constructed in concrete. Such portions will form only 5 to 6 percent of the total quantity of dam. This figure is based on the assumption that cement mortar 1 in 4 will easily attain a breaking strength of 2,000 p.s.i. at 28 days and thus restricting masonry to a limiting working stress of 300 p.s.i. will give a minimum factor of safety of about 7 which is considered sufficient and safe.
- (ii) The downstream face of the spillway portion to the extent of 5 ft. measure normal to the face should be done in concrete.
- (iii) A septum of concrete 5 ft. wide at top and 10 ft. at the deepest portion and 5 ft. from the upstream face as an

extra precaution against any possibility of seepage through the masonry as proposed by the Chief Engineer (Koyna) may be done.

- (iv) In case of structures like the spillway apron, portion around galleries, penstocks, and spillway piers etc., and where reinforcement or anchoring are necessary will in any case be done in concrete.

II(b) Even if masonry construction is adopted for the whole dam, it is felt that the time schedule could be maintained provided the supply of materials is sufficiently mechanised as is proposed to be done for concrete.

II(c) No special difficulties are anticipated in obtaining the necessary force of masons and other labour.

III. Third term of reference

Whether two separate agencies for the masonry and concrete parts of the dam are feasible.

Having taken a decision on Item II that an all masonry dam is feasible and could be adopted, the question of two construction agencies, one for concrete and the other for masonry does not arise as the quantity of concrete will be much reduced.

In any case in view of the restricted space of operations and several common items in both portions in a concrete-cum-masonry dam, two construction agencies are not considered desirable and should be avoided.

IV. Fourth term of reference.

In case the work has to be done departmentally what plant is likely to be required. What time the acquisition of this plant will take.

As regards the plant and machinery to be purchased for carrying out the work departmentally the same will have to be carefully worked out. The Koyna Organisation has worked out a list of machinery needed. In view of the decision that an all masonry dam is feasible this list will have to be revised to suit that type of construction.

As discussed under Item I, the Planning and inquiries for plant should be proceeded with, and by the time the results of the tenders advertised, are received, they should be brought to a stage just short of actual purchase.

- (i) P. L. Bhargava, Member (Designs), Central Water and Power Commission, Delhi.
- (ii) U. N. Mahida, Chief Engineer (Irrigation) and Joint Secretary, Public Works Department, Bombay.
- (iii) M. L. Champhekar, Chief Engineer, Koyna.

APPENDIX VIII

ITEM NO. VI OF 17TH MEETING OF KOYNA CONTROL BOARD
(APRIL '56)

Koyna Hydro-Electric Project—Tail Race Tunnel—Departmental execution of.

At the 16th meeting of the Board held on 8th and 9th February 1956, it was decided that the Financial Adviser should go through the specifications for Tail Race Tunnel and the Chief Engineer, Koyna should proceed with the invitation of tenders after taking his remarks into consideration. The Financial Adviser accordingly scrutinised the specifications and found them in order and had no modifications to suggest. Subsequently the Minister, Public Works Department and Chairman of the Board had telephonic conversation with Shri G.L. Nanda, Minister for Planning, Government of India, in connection with the execution of the Koyna Project. During the conversation Shri Nanda expressed the view that the whole work of the Koyna Project should be done departmentally. The Minister, Public Works Department, explained to him the difficulties of departmental execution but agreed that some works may be considered for departmental execution.

The Minister in consultation with the Chief Engineer, Koyna has proposed that the work of constructing the Tail Race Tunnel estimated to cost Rs. 1.1 crore, may be done departmentally.

The proposal is for the approval of the Board.

सत्यमेव जयते

APPENDIX IX

LIST OF THE SPECIAL CLAUSES ENTERED INTO WITH THE SUCCESSFUL TENDERS WHICH WERE NOT INCLUDED IN THE ORIGINAL TENDERS

A. Dam and Appurtenances

(1) Government would secure or help to secure permits, licenses and priorities for delivery, transport, etc., for temporary and permanent works. In the case of delay in procuring the above licenses, facilities or priorities exceeding 6 months from the date of requisition sent to the Engineer, the contractor would be entitled to compensation for loss in actual cost of labour, machinery and overheads, by reason of such delay.

(2) Contractor would be entitled to compensation on account of delays in supplying cement or electricity etc., beyond certain minimum periods specified in contract.

(3) The Government would bear the extra liabilities on account of (a) variations in import duties on plant, and (b) price fluctuations oils etc., in excess of 5%.

(4) Contractor would be allowed a rebate of Rs. 2/5 per ton for cement supplied, to compensate for the possible transit losses.

(5) An advance payment of 90% and 75% of cost of imported plant and township respectively would be made to the contractor (the tendered figures were 75% and 50%) and the recovery of the advances is governed by additional clauses proposed by the contractors.

(6) Guarantee Bond from a scheduled Bank or Insurance Co. in lieu of cash as stipulated at the time of tendering.

(7) Government would pay the contractor 15% overheads for works carried out in deficit of 90% and 95% of tendered value of work in the case of items of the Dam work, and grouting work respectively.

(8) Maximum penalties in case of default is reduced from 25% to 17% of the value of the work tendered.

(9) Changes in lead of materials due to changes in the quarries are to be treated as extra items.

B. Intake to Emergency Valve Tunnel

Advance payment to the extent of 90% cost of plant and equipment, spare parts, and tools as landed at Bombay or of original price in the country.

C. Tender for Pressure shafts, Power House and Appurtenances

(1) Government would pay compensation to the contractor for increases in the costs of labour, taxes, freight transport, Insurance and materials over and above the rates prevalent at the time of tender and also as a result of possible war.

(2) The increase in cost due to fluctuations in labour rates due to Government legislation under minimum wages act (1948), in excess of 10%, should be borne by Government.

(3) Any increase in prices of oils and lubrication in excess of 2 1/2% should be borne by Government.

(4) Any increase in taxes, viz., sales tax, Import duties on machinery and spares, octroi and other Government taxes on machinery and plant etc., required for the work should be borne by Government. Similarly any increase in rates of Rly. freight and insurance is to be adjusted.

(5) If work on any of the items is stopped for failure of electric supply, cement, steel and water for more than seven consecutive days at any time, contractor is to be compensated for idle labour, machinery and overheads for such periods beyond 7 days, and given suitable extension of time. (Supplies less than 66% of assessed requirements in the case of Power supply are to be treated as failure to supply).

(6) If the work is prolonged after 31st March, 1961, unless such prolongation is requested by the contractor, he should be entitled to compensation.

(7) The size of the Penstock Adit shall be increased to 10×10 and paid at contractor's rates.

(8) Contractor should be paid Rs. 65,000 for maintaining the road to Adit for Penstocks or else Government should maintain the same.

(9) Actual working drawings shall not radically vary from tendered drawings, and any work not mentioned in the schedule, shall be considered outside the scope of the tender, even if it were shown on the drawings.

(10) Contractor shall be compensated for changes in the programmes of construction once approved.

(11) Contractor shall be paid 20% for overhead reduction in executed work below a limit of 90% of tendered value of work. If the work executed exceeds by more than 10% of tendered value, the contractor would allow a rebate of 5% for such excess.

(12) The variations in cost due to war, or Force Majeure would be subjected to arbitration.

(13) The settlement of labour dispute shall be decided by Engineer, only if they cannot be decided by recourse to law.

(14) Contractor reserves the right to take any dispute to arbitration, if he does not agree with the decision of the Engineer.

(15) Contractor is entitled to extra payment for any additional supports in the tunnel.

(16) Contractor should be paid advances to the extent of 90% of cost of the imported plants instead of 75%, and 75% instead of 50% of the cost of township, buildings and roads etc.

D. Steel lining for H.R.T. Surge, Take offs and Pressure Shafts

(1) A compensation of Rs. 2.442 lakhs should be paid to the Contractor to cover the contractor's overheads of supervision and establishment during the Monsoon months, if as no pipe laying can be done then when the concreting is not going on in monsoon season.

(2) Government should arrange for a release of foreign exchange to the tune of Rs. 40 lakhs and excess or saving on this score as a result of changes in rate of exchange shall be borne by Government.

(3) Sales tax, General Tax, local tax etc., shall be borne by Government.

(4) Government shall bear extra liabilities arising out of increase in cost of labour and conditions of their service, cost of controlled articles, customs duties, sales tax, Railway freight, rates of marine insurance etc.

(5) In the case of supply of steel plates in sizes smaller than the specified, Government shall compensate the contractor for the extra, joints, according to a formula given by the contractor.

(6) Concreting for rail track should be paid extra.

(7) Increase in prices of Rustproof Shalimar paint shall be on Government Accounts.

(8) If the total weight of the actual steel lining falls short of the tendered weight by more than 2 1/2%, Government shall compensate the contractor for overheads etc., according to a formula given by the contractor.

(9) Advances to the contractor should be to the extent of 90% instead of 75% for plant and equipment.

(10) For factory Buildings, 75% cost should be paid as advance instead of 50%.

(11) An advance to the extent of 70% of cost of backing plates shall be paid to the contractors (Original tender provided nothing).

(12) Contractor shall not be responsible for delays on account of reasons beyond the control of the contractor.

(13) Payment of advance for supply of space bonds, Y-pieces and penstocks shall be done as follows:—

- (i) 20% within one month of signing of contract.
- (ii) 30% on arrival of the plates in workshop.
- (iii) 10% after hydraulic testing of the 1st penstock.
- (iv) 10% after hydraulic testing of the 2nd penstock.
- (v) 30% as soon as the shipping documents are handed over.

(14) Price variation due to rise in cost of labour and materials as prevalent on a particular date in Switzerland are to be effected according to a formula given by the contractors.

(15) Contractor can take any dispute to arbitration if he does not agree with the decision of the Engineer.

(16) Annealing, if insisted on, shall be charged of Rs. 100 per ton. Heat-treatment of site-welds shall be paid at Rs. 26 per Rft. of the welds subject to a minimum of Rs. 50,000 as compensation for providing, maintaining and taking away the necessary equipment to do this work.



APPENDIX X

Summary record of the proceedings of the meeting with the representatives of the Koyna Project Authorities and the Irrigation and Power Team held on Thursday the 23rd October, 1958 at Sachivalaya, Bombay.

Present

Shri N. V. Gadgil Governor, Punjab & (*in the Chair*)

Leader, Irrigation and Power Team

Shri S. R. Desai

Minister for Public Works, Bombay

Shri S. K. Wankhede

Minister for Planning and

Development, Electricity and Industries, Bombay

Shri N. N. Iengar

Member, Consultative Committee and I & P Team

Shri S. G. Barve I.C.S.

Secretary, Public Works Department &

Secretary, Koyna Control Board

Shri Balwant Singh Nag

Member, Irrigation and Power Team

Shri M. P. Mathrani

Member, Irrigation and Power Team

Shri N. G. K. Murti,

Chief Engineer, Koyna Project

Shri G. N. Pandit,

Chief Engineer (Irrigation Projects), Bombay

Shri V. R. Vaidya

Chief Engineer (Electrical) Koyna Project

Shri D.B. Anand,

Chief Engineer (Irrigation), Bombay

Shri D. S. Borker

Secretary, Consultative Committee,

Irrigation and Power Projects and Team.

Initiating the discussions, Shri N. V. Gadgil, Leader of the Irrigation and Power Team remarked that the Koyna Dam should be built to its full width in order to derive the full benefits of the available storage.

2. Shri S.G.Barve explained that unless additional diversion to Arabian Sea was allowed, full benefits could not be exploited. At the Leader's suggestion, Shri N. N. Iengar clarified that no extra diversion over and above the 67.5 T.M.C.Ft. of water allocated for

power could be contemplated in view of the inter-state agreement. The extra benefits referred to by the Leader pertained to available irrigation and the incidental increase in power generation at the Main and Dam Power Houses as suggested in the Report.

3. Referring to the correspondence with the Chief Minister, Mysore, Shri N.V. Gadgil observed that the Mysore Government would like to reserve the right to utilise 46 T.M.C. Ft. of Koyna waters in its own territory and that he considered that this was not much helpful in taking a decision to building the dam to its full width. Shri D.B. Anand added that 46 T.M.C.Ft. was not meant for Bijapur Lift in any of the sanctioned Projects. Shri N.G.K. Murti pointed out that 44 T.M.C.Ft. was mentioned in the Gupchup report. Shri M.P. Mathrani drew attention to the proceedings of the inter-state conference of 1951 for allocation of Krishna waters. The demand for 46 T.M.C. Ft. of water had been shown against the Koyna Irrigation Scheme and presumably the Government of Mysore had that figure in mind.

4. Shri N.N. Iengar pointed out that the economics of the Dam power house had not yet been properly investigated. He added that there were possibilities for the sale of seasonal power generated by it to replace thermal power and firming up this power by storing and releasing irrigation waters, by arrangements with other States which possessed the irrigation rights. With the dam storing 98.7 T.M.C. Ft. of water and without irrigation releases, the total extra generation of the main power house would be of the order of 50 M.K.W. Hrs. and with regulated irrigation releases (at the main and Dam power houses) about 140 M.K.W. Hrs. This factor alone would justify providing the dam power house and raising the dam, pending agreements with lower State regarding sharing the costs of storage, which when completed would add to the advantages to Bombay. In replying to a query by Shri G.N. Pandit, Shri Iengar confirmed that the proposals for additional investment and the accruing advantages were in respect of a dam to store 73 T.M.C.Ft. and not 57.3 M.C.Ft.

5. Referring to the power aspects of the Project, Shri N.G.K. Murti said that the economics of the Dam Power house had not been studied as it was intended to construct the dam power house in the third stage. He confirmed the general accuracy of the additional generation capacity computed in the Team's report, however, this additional power would be needed only after the power generated by the Koyna Project (second stage) was consumed *i.e.*, by about the year 1970.

6. Shri M.P. Mathrani said that the Team had proposed only widening of the Dam and not raising it for full storage since subsequent widening would be very difficult and more costly due to rise in rates, cost of additional establishment and other overheads. Shri Balwant Singh Nag remarked that the extra construction proposed by the Team was only of an incremental nature.

7. At this stage, Shri S.G. Barve observed that the question of extra cost was marginal and not a matter for so serious a consideration as the possibility of this proposal resulting in the postponement of the main Power development by one year. This was so, particularly in view of the fact that the present programme was extremely tight and if the target for dam concreting was missed even by a month's progress, there would be postponement by one year in power generation. Shri Mathrani stated that the Teams's view of the concreting capacity was based on the general experience and knowledge. Shri Blawant Singh Nag added that none among the Teams's membership shared the optimism of Shri N.G.K. Murti as it involved great risks to plan with the present arrangements. Shri S.G. Barve pointed out that Shri N.G.K. Murti was willing to review the matter sometime in the next month. Shri N.G.K. Murti said that the original contract was only for 31 M.C.Ft. and the quantities had already been increased to 36 M.C.Ft. The Team's present proposal involved addition of another 3.7 M.C.Ft. which would surely land the project in difficulties.

8. Shri S. R. Desai, Minister for Public Works, Bombay Government expressed the view that prolonged discussion with Mysore Government might involve long delays and losses, which must be avoided. Shri S.G. Barve emphasized immediate necessity (i) to avoid postponement of power generation (ii) ascertain what the contracting firm would demand if asked to do the additional work and (iii) that the question of obtaining commitment from Mysore Government to share the costs of storage should be examined.

9. In summing up, Shri N.V. Gadgil observed that the advantages to be gained by incurring the extra expenditure on the full dam should be weighed against the likely loss due to one year's postponement of main power generation. Shri Iyengar had pointed out that such a postponement might be a catastrophe and was unthinkable.

In view of the practical difficulties it would be better to go ahead with the construction work according to the schedule. The question would be reconsidered in a meeting to be held, preferably at the dam site after about one month. It was hoped that meanwhile Shri Murti would be able to ascertain definitely whether it would be possible for the contracting firm to lay the extra concrete in time and the cost involved.

LETTER FROM GOVERNMENT OF BOMBAY REGARDING
THICKENING OF DAM SECTION

Most Immediate

No. GKP 5958-IV/171722-N.

Public Works Department,
Sachivalaya,
Bombay No. 1, 26th November
1958.

From

Shri S. G. Barve, I.C.S.,
Secretary,
Public Works Department,
Sachivalaya,
Bombay No. 1

To

The Secretary,
Consultative Committee on Plan Projects,
(Irrigation and Power Team),
Krishi Bhavan, Queen Victoria Road,
New Delhi.

*Subject—Koyna Project—Thickening of the Dam Section for
storage of 98,700 M.C. Ft.*

*Ref—Paragraph 5.6 of the Draft Report and subsequent discussions
on the same at Bombay on the 23rd October, 1958.*

Sir,

When the Draft Report on the Koyna Project was discussed in Bombay on the 23rd October 1958, the Leader of the Team had suggested that the Chief Engineer, Koyna, should ascertain definitely whether it will be possible for the contracting firm to lay the extra concrete necessary for building the Koyna Dam of the thickness required for the storage of 98,700 M.C. Ft within the scheduled time and if so report the additional expenditure which will be incurred on this account.

Detailed discussions were accordingly held recently with the Contractors. Dr. K. L. Rao, Member, Central Water and Power Commission who was requested to be present also participated in these discussions. The existing plant capacities and production schedules were very carefully examined with a view to ascertain whether the contracting firm could guarantee laying of about 35 M.C.Ft. of rubble concrete by April or May 1961. After examining the

conditions at site of work and reviewing the work done so far, the conclusion of the Contractors that they would be unable to guarantee laying of more than 31 M.C.Ft. by March 1961 appears to be fully justified.

Though it was presumed during the discussions on the 23rd October 1958, that the only difficulty in our way was the limited cable crane capacity. Our recent discussions show that not only the placing mechanism but also the entire crashing and mixing mechanism would need to be supplemented. The crushing mechanism which is not easily available would not be in position for another 12 months and as a result the peak performance will be concentrated in a fraction of the season of 1959-60 and in 1960-61. The Contractors also ask for reimbursement of the additional cost that such installation would entail for them. It will further be appreciated that a considerable amount of foreign exchange expenditure will be involved in the additional cost.

The mass concrete in the Contract is 18.9 M.C.Ft. based on a rubble percentage of 44. The Contractors have expressed inability to achieve a percentage higher than 33-1/3% rubble and 62-2/3% concrete. This will increase mass concrete in the Contract to about 22 M.C.Ft. For a dam of 73 M.C.Ft. Section nearly 25.2 M.C.Ft. of mass concrete would be required. If the section of the dam is further thickened to 98,700 M.C.Ft. the mass concrete quantity will be increased to 28.7 M.C.Ft. The increase for 73,000 M.C.Ft. section is of the order of 33% and that for the 98,700 M.C. Ft. Section is over 50%. This additional work cannot be handled with the existing plant which has been installed at the site. From the analysis given above it appears that the thickness of the dam cannot be further increased for the storage of 98,700 M.C.Ft. without postponing the target date of commissioning the first generating set at the end of 1961 monsoon.

I am, therefore, to request that this letter may be placed before the Leader before the forthcoming meeting which is proposed to be held on the 6th December 1958 at Bombay.

Yours faithfully,

Sd/- S.G. BARVE

*Secretary to the Govt. of Bombay,
Public Works Department.*

APPENDIX XI

*STATEMENT SHOWING OBSERVATIONS AND RECOMMENDATIONS OF THE IRRIGATION AND POWER TEAM ALONGWITH COMMENTS OF BOMBAY GOVERNMENT. AND CENTRAL WATER AND POWER COMMISSION, & FINAL REMARKS OF THE TEAM

Sr. Para-graph No.	Observations and recommendations made by the Team.	Comments of Bombay Government	Final Remarks of the Team	
(1)	(2)	(3)	(4)	(5)
1.	2-5 Sanction of staff is sought from the Government every year which necessarily increases the work of the Control Board and the Chief Engineer. The Team recommends that the Chief Engineer may be authorised to operate upon an overall sanction for the project period.	The feasibility of accepting suggestions would need further examination. Merits of the suggestions, however, are recognised in Public Works Department but would need to be referred to the Finance Department before implementation.	Accepted in principle by the State Govt.	
2.	2-5 The Team suggests speedy consideration as well as implementation of the Koyana Control Board's resolution to give temporary non-gazetted staff a lien on similar posts in permanent circles to create a greater sense of security in service and incentive to work.	Action is already under way.	Accepted by the State Government.	
3.	2-5 The Team recommends creation of the permanent posts required on completion of the project and absorption of deserving personnel there against so as to give a further impetus to the efficiency of the staff.	Accepted in principle so far as staff on the Electrical side is concerned. This will need further examination because the project is likely to be managed after completion by the State Electricity Board which is an autonomous body having its own technical and non-technical cadres. Proposals for the creation of permanent posts and absorption of	Accepted in principle by the State Govt.	

*Comments of the Central Water & Power Commission may please be seen at page 130

*Comments of the Central Water & Power Commission may please be seen at page 130

personnel against them will have to be formulated in consultation with the State Electricity Board. Government, however, is prepared to do its best for implementing the suggestion.

4. 3-7 All the 240,000 KW of Electricity generated on completion of the first stage of the project is expected to be consumed by October 1964, and therefore, it would not be possible to postpone the second stage by 10 years as originally contemplated. It is, therefore, necessary to merge the second stage with the first and to rephase the project so that the 5th unit of the project is commissioned soon after October 1964. It would, therefore, seem necessary that the dam should be raised in continuation of the first stage to a height sufficient to store 57,000 MCFT. of water required for second stage power generation.

Accepted by the State Govt. Further action to be taken in Planning Commission when project estimate is received.



5. 3-8 The cost and selling rate of power are stated in October 1956 project Report as 0-38 and 0-45 anna per unit respectively. These rates are neither related to what the industries can pay without detriment to their progress, nor to costs of thermal power as an alternative. It is hoped that the Tariff Committee will duly weigh these factors and decide upon tariffs which after meeting the working expenses, interest and depreciation charges, will yield sufficient surplus for reserves and contingencies.

The Tariff Committee is going into all the aspects pointed out.

Accepted by the State Govt.

APPENDIX XI (contd.)

(1)	(2)	(3)	(4)	(5)
6.	4-1	It is the view of the Team that the main concern in utilisation of power should be to avoid concentration of industries in Bombay Area, if the problems arising from such concentration are to be avoided. It would, therefore, be desirable to give priority to the establishment of as many industries in the Koyna area as possible, thereby enabling exploitation of the natural resources locally available such as bauxites as well as other raw materials which can be economically brought by sea for electro-chemical and other industries.	The Koyna Sholapur Scheme should be included in the core of the Second Plan. A Committee has been appointed by the Industries and Co-operation Department of the Bombay Government for framing appropriate proposals for examining the question of development of loads in the Koyna region. Suitable action will be taken on the recommendations made in the Committee's Report.	Accepted in principle by the State Govt. The Planning Commission may examine the feasibility of including it in the core of the Second Plan.
7.	4-2	The ample tail waters should help in developing the Dabhol Creek into a port. The potentiality of this Creek in this regard should be specifically brought to the notice of Government of India.	This has already been brought to the notice of the adviser on ports (Shri H. P. Mathrani) who has been requested to visit the site. Inland Waterways Committee under the Chairmanship of Shri B. K. Gokhale, I. C. S. (Retd.) was to inspect this creek on 8th December 1958 but the inspection has been postponed to February 1959.	Accepted in principle by the State Government.
8.	4-3	It should be possible to irrigate about 5,000 acres of land on the banks of the tail race channel by diverting a fraction of the tail waters. This as well as other possible uses of tail water such as water supply to towns and villages etc., should be investigated.	It is a minor irrigation scheme (5,000 acres). However, it will be considered. Public Health Department is already planning to give water supply to Chip-lun Town from this source. As industrial development of this area begins to take place other ways of utilising the tail waters will be found.	Accepted.

9. 4-5 The Koyna Dam was originally planned to store 98,000 M.C. Ft. of water (57,000 for power, 31,000 for irrigation and 10,000 for carry over). Since November, 1956, Bijapur District has been transferred to the reorganised Mysore State. In May 1958, the Bombay Government decided to utilise 16,000 M.C. Ft. of water for flow irrigation of about 1 lakh acres in North and South Satara Districts in Bombay State. The project estimate for this irrigation scheme is not yet ready. The feasibility of this irrigation scheme, therefore, cannot be judged at present. The Government of Bombay addressed the Government of Mysore in May 1958 regarding sharing the cost of storage required by Mysore State. Mysore Government has not yet taken a decision. The two States should come to an early agreement so that the programme of construction for the full development can be finalised.

10. 4-6 All the four States between whom the Krishna waters were allocated by the Planning Commission in 1951 have undergone major territorial readjustments during the reorganisation of the States. The Team urges immediate reallocation of Krishna Waters among these States to avoid complications in the preparation of new Projects by the reorganised States.

Government of Bombay are reminding the Ministry of Irrigation and Power to give clearance to the construction of 73,000 M.C.Ft. section of dam as Mysore is not asking for (and concurrently agreeing to pay for) supply of any part of the Koyna storage at present. The reservations made in the Mysore Government's letter are not relevant.

The Irrigation scheme is feasible as it envisages making perennial the 80 years old Krishna Left Bank Canal where a sugar factory is already under installation. The Right Bank will respond equally quickly to irrigation facilities. It will be cheaper than any other completely new irrigation scheme in Deccan as we are only supplementing an existing canal where a little expenditure in remodelling is needed with a new canal on the other bank. A preliminary report on the Irrigation Scheme has already been prepared and submitted to the Team.

The Bombay Government agrees. The initiative for this must, however, be taken by the Planning Commission.

Mysore Govt. have stated that it would not ask at the present time for any storage in Koyna reservoir for irrigation purposes in Mysore State provided that the storage in Koyna is so phased that it will be possible for Mysore to utilise its shares of Koyna water in Mysore State. The urgency of re-allocation of Krishna waters on account of reorganisation of States is stressed.

The irrigation project prepared by Bombay State is a preliminary one. The capital cost per acre of mixed crops on the basis of that project works out to Rs. 1,075 which is rather high. The project authorities are considering certain alterations to cheapen this project. The feasibility from economic point of view can be judged only after the final irrigation project is prepared. The gross cost of the project including the cost of head works and of existing Krishna System is Rs. 1,075 lakhs. For a scheme of this magnitude a comprehensive detailed project is called for.

A very early action is called for for reallocation of Krishna waters on account of reorganisation of States.

APPENDIX XI—(contd).

(1)	(2)	(3)	(4)	(5)
11.	5-2	<p>The tempo of some of the works like concreting of the dam and excavation of pressure shafts is not at present adequate to achieve the revised target of power generation in April 1961. The capacity of the concreting rig is only about 60% of that required for completing the job in time and needs to be supplemented immediately. Similarly steps need to be taken to improve the technique of excavation of the pressure shafts so as to achieve the required progress. The steel lining of pressure shafts may also prove a bottleneck and may require foreign expert supervision. The project authorities have standing arrangement with their Swiss Consultants for obtaining advice and assistance of experts in the line when necessary. This may be availed of if any difficulty is experienced.</p>	<p>The contractors have laid about 0-48 M.C. Ft. of concrete in October 1958 and 0-72 M.C. Ft. in November 1958 against our expectation of 0-5 and 0-75 M.C. Ft. and against the maximum assessment of 0-9 M.C. Ft. made by COPP. December 1958 and January 1959 performance has to be watched before it can be said that placing mechanism has inadequate capacity. The position will again be reviewed at the end of January 1959, and remedial measures, if found necessary, will be taken immediately. Adequate steps are being taken to improve the progress on the execution of the pressure shafts.</p>	<p>The output of concreting plant of 0-9 M.C. Ft. per month given by the Team is average and not the maximum as indicated by the project authorities. It is the average for the whole construction period. The progress of concrete will, therefore, need very close watching.</p>
12.	5-3	<p>The Thana Creek Crossing which is a complicated work may prove yet another bottleneck unless immediate steps are taken to start construction there.</p>	<p>The contractors who are fabricating and installing steel lining have executed an agreement with their foreign collaborators under which foreign technicians of various categories like engineers, foremen, etc. will be provided by the consultants to the contractors, namely Messrs Indian Hume Pipe Co. Ltd., on terms which have been mutually agreed upon.</p>	<p>The position regarding fabrication and installation of steel lining would also need to be closely watched by the project authorities.</p>
				<p>The progress on construction of this work will need careful watching.</p>

5-5
to
5-13

According to 1956 October estimate, ... spillway portion of the dam was to be constructed of full width required for the final storage of 98,000 M.C. Ft. both in foundation and superstructure. In the non-spillway portion the foundations were to be of full width required for the final storage, but the superstructure was to be of a width required for the 1st stage storage of 36,000 M.C. Ft. On account of the expected rapid load development, as it would not have permitted of a time lag of 10 years between construction of 1st and 2nd stages which was considered necessary for attaining equilibrium of the 1st stage concrete before the 2nd stage concrete could be started, the Bombay Government have modified this programme. In this modified programme it is proposed to construct foundations of the spillway portion to full width required for final storage, but the superstructure has been reduced to suit a storage of 73,000 M.C. Ft. required for power and irrigation in Bombay State. The non-spillway portion is proposed to be constructed both in foundation and superstructure of width required for a storage of 73,000 M.C. Ft. This modification in the programme is likely to make the construction work for the final storage of 98,000 M.C.Ft. both difficult and costly. The cost of the extra work on dam for storing 98,000 M.C. Ft. instead of 73,000 M.C. Ft. will be only

The views of the Bombay Government on the merits per se (as distinguished from the "expediency" for which consideration the Team have already conceded to the Bombay Government's view point in the next sub-paragraph) of the proposal to build the dam *now* to a thickness relevant to a storage of 98,000 M.C. Ft. have already been supplied to the Team on 23rd October 1958 in a separate note as well as in our letter, dated the 26th November 1958.

The final storage of 98,000 M.C. Ft. is not likely to be required in the proximate future. If and when required the strengthening of the spillway section can be done along with the non-spillway section.

We agree that after completion of first stage work, the work of the second should be carried in continuation upto the level of storage for 57,000 M.C. Ft. required for power (without gates).

Indeed, considering the ready utilization of the irrigation waters which is likely to occur and the relatively low cost involved, it may be found subsequently that it is beneficial to continue the work of "the second stage power" further to include irrigation and attain a storage of 73,000 M.C.Ft.

As already mentioned feasibility of the irrigation scheme from economic point of view will need examination before raising of the dam is undertaken beyond storage of 57,000 M.C. Ft. required for power.

The project authorities have not agreed to the small change suggested in the construction programme of thickening the super-structure of the spillway portion which was provided in the sanctioned estimate before the re-organisation of States. The project authorities had previously considered that it would be impossible to do this work later on. The work would be extremely difficult and not as sound as it would be if it were done now. This work will be useful even from power generation point of view. The quantity of concrete required to be done is so small that it should not affect the target for generation of power by May 1961. The Team, therefore, advises this work to be undertaken in the present programme of construction. It would take a year before the foundations are completed and the stage for thickening the super-structure in the spillway portion is

APPENDIX XI—(contd.).

(1)	(2)	(3)	(4)	(5)
		Rs. 2.2 crores. This extra cost is amply justified both on account of the additional benefits of power and irrigation.		reached. By that time Mysore should be able to come to a final decision.
		<p>The modification in the construction programme to finish both the foundation and superstructure of the dam to full width required for 98,000 M.C.Ft. storage would involve an additional quantity of 3.7 M.C. Ft. to be finished by May 1961. It is understood that this increase in quantity of concrete to be finished by May 1961 will lead to complications with the contractors in respect of rates and completion programme. It is considered that any further postponement in generation of power will have serious dislocating consequences in the industrial activity in Bombay region. In view of these difficulties, it would not be advisable to alter the programme of construction materially. It is, however, considered that there will be great difficulty in thickening the superstructure of the spillway portion later on. Apart from constructional difficulties, there will be very limited time during the working season to do this work. The total extra quantity of concrete involved in this work is 0.88 M.C. Ft. of which only 0.55 M.C. Ft. will need to be done before May 1961. This will mean an</p>	<p>There is, however, time during which this further aspect would be considered. In particular it would require preparation of a detailed project report for the irrigation scheme. We would, however, suggest that a mention of this possibility may be made by the Team in its recommendations. A preliminary report on the irrigation project has already been submitted to the Team.</p>	

increase of about 2% in the quantity of concrete or about a fortnight's work for the concrete laying equipment. The Team, therefore, recommends that the present programme of construction may be adhered to except for the small modification suggested in the spillway superstructure in constructing it to a thickness required for ultimate storage of 98,000 M.C. Ft.

After completion of the 1st stage work, the work of the 2nd stage should be carried out in continuation upto the level for storage of 57,000 M.C.Ft. required for power (without gates).

14. 5-14 In view of the necessity to develop the 2nd stage power by 1965, the 3rd and 4th pressure shafts will also have to be completed before that time. This may be done departmentally as rock excavation work at present being done by the Department is much cheaper than similar work being done through contractors. It would be desirable to take up this work immediately the tail race tunnel, which is being done departmentally, is finished. This should be suitable as it would combine organisational interests with the requirements of the project.


15. 6-5 The contractors are entitled to a rebate of Rs. 2/5 per ton in lieu of losses of cement in transit which it is understood are actually more than what had been originally anticipated. It would,

The Bombay Government agrees. It is, however, pointed out that an early clearance from the Ministry of Irrigation and Power is needed. It will be necessary to excavate the second cable tunnel also.

The clearance for this work may be given by the Government of India after estimate for second stage of power development is sent by the State Govt.

This was taken up with Messrs Bagalkot Cement Company and the present supplies are considerably better.

APPENDIX—XI (contd.)

(1)	(2)	(3)	(4)	(5)
		therefore, be desirable that all the necessary steps are taken to reduce these losses to the minimum.		
16.	6-8	There are considerable delays in procuring import licenses. In some cases the goods arrived and have been lying in docks for over three months as they could not be cleared for want of licenses. These delays need to be minimised otherwise construction targets may be affected. This matter needs to be brought to the notice of the concerned Ministries in the Government of India. The Team suggests that a senior officer not necessarily a technical person may be deputed for liaison work in this connection.	<p>Government is fully apprised of the position and it is proposed to depute a high-powered officer to Delhi periodically for personal discussion with officers working in the various Ministries and attached offices for clearing up cases on which action needs to be taken urgently.</p>  <p>About claims it is difficult to say anything at present.</p> <p>Actual establishment charges are nearly Rs. 30 lakhs per year. Total provision is Rs. 295.3 lakhs which is not likely to be exceeded even with a little delay.</p>	All steps should be taken to complete the project by the target date.
17.	7-1	The Project Authorities anticipate an excess of Rs. 2.31 crores on certain items and a saving of Rs. 2.16 crores on other items including contingencies. Savings on contingencies may not come about as there are many clauses in the contracts which may cause excesses. The establishment and repairs overheads will cause an excess of about Rs. 40 lakhs annually, if the works are not completed in time of which there is a likelihood.		
18.	7-2	(i) The spill over to third plan from stage I estimate, according to present expectations would be Rs. 6.83 crores.	The Government of Bombay have already asked for Rs. 4 crores beyond the Plan provision of Rs. 29 crores.	The Planning Commission may consider this in due course.

The actual figure would depend upon the progress that is achieved in the next two years specially in laying concrete in the dam.

(ii) The total project expenditure forecast for the period ending March 1958 was about Rs. 18.9 crores and the actual expenditure was only Rs. 9 crores. This has necessitated rephasing of expenditure. The allocation of Rs. 29 crores for the Second Five Year Plan is not likely to be exceeded.

(i) The foreign exchange figure supplied were originally computed on the assumption that all the steel and cement may have to be imported which may not now fully be necessary. All cement is likely to be available from within the country.

(ii) The foreign exchange required for 20 tons cableway or any alternative device recommended by the team can be met from the provision under construction and other equipment.

A comparison of provision of residential areas and expenditure thereon for different categories of personnel on various projects reveals a great deal of diversity. The Team recommends that the Ministry of I. & P. should lay down standards both as regards type of construction and size of accommodation in consultation with the Buildings Projects Team of COPP.

No remarks.

Foreign exchange requirements were assessed in consultation with Ministry of Finance, Government of India and the World Bank's team regarding the types of expenditure that can be accepted by the World Bank for reimbursement.

Necessary action may be taken in the Ministry of Irrigation and Power.

No comments.

APPENDIX—XI (Contd)

(1)	(2)	(3)	(4)	(5)
21.	8.4	<p>As the lowest suitable tenders for three major works exceeded the estimates by 23% to 30% the Chief Engineer, Koyana does not seem to have been in favour of letting out the works to contractors. In the case of contract for the dam, he definitely recommended that the work should be carried out departmentally. The Koyana Control Board, however, took a decision to accept tenders for these works. No detailed reasons are available on record as to why the works were let out on contract.</p>	<p>The matter was at the relevant time discussed in great detail in the Koyana Central Board before the final decision was reached. Obviously, the decision depends upon the judgement that a particular authority may frame in the light of all known circumstances about the feasibility of carrying out such a large work departmentally. The difficulties of departmental construction are quite well known. It was not considered necessary to state specifically these difficulties which are of common knowledge. In such matters which ultimately depend on the judgement of the highest authority charged with the particular decision, it is comprehensible, we feel, that no necessity was felt to place on record detailed reasons. The then Chief Engineer (Koyana) favoured departmental construction. The Koyana Control Board and on the Board's advice the Government came, however, to the judgement that the contractual method of execution was preferable to the departmental. The judgement of the higher authority prevailed. It is not understood why in these special circumstances the Team wish to suggest that the obvious reasons ought to have been recorded explaining as to why a different view was taken.</p>	<p>With a view to avoid extra cost in construction of big Projects through contract agencies, steps should be taken to remove difficulties in departmental execution in future.</p>

22. 8.5 The rate worked out by Chief Engineer, Koyna for the underground excavation of tail race tunnel which is being done departmentally is Rs. 102/- per hundred C. Ft. against a contract rate of Rs. 152/-. The concrete lining of this tunnel is also proposed to be done departmentally. This being the only work done departmentally, it should provide valuable data regarding the actual rates for (i) underground excavation in rock and (ii) concrete lining of tunnels.

No comments.

23. 8-11 The contractors of such large work provide for all sorts of contingencies which may or may not arise. Their rates include write off of most of the plant and machinery although these have considerable residual value. They have to provide for a fair margin of profit. Therefore, their rates naturally are high. The tenders are usually hedged in by many special clauses to safeguard contractors' interests. Services like water supply, electricity and roads and supply of important materials like steel and cement have to be provided by Government. Also foreign exchange and funds for machinery have to be provided by Government. After completion of work, Government has no lien on plant and machinery, for which foreign exchange has been made available. In view of

This is a general issue of wide repercussions.

So far as it is concerned, the Bombay Government is of the view that as at present organised and constituted the Public Works Department will not be able to cope with the practical implications of this decision; namely undertaking, over and above the works that are already in hand departmentally, all the use of such magnitude involving the use of considerable machinery and plant and extending over a number of years."

This issue was discussed in detail recently in a conference of Chief Engineers with the Secretary, Public Works Department and an extract of the relevant conclusion is reproduced below.

This is no doubt a general issue. The Team's remarks are intended for large projects like Koyna where considerable machinery is required and which take a number of years for completion. Execution of individual works not requiring much machinery by contract, where there is keen competition and rates are economical, is not ruled out. There are difficulties, no doubt, in departmental execution but they need to be overcome to save costs.

APPENDIX—XI (contd.)

all these consideration, it would be advisable that works of such magnitude involving use of considerable machinery and plant and extending over a number of years should be done departmentally using Government machinery and employing small contractors or piece-workers. If the difficulties in the departmental execution such as delays in procurement of machinery and spare parts, getting sanction for the necessary staff and in fixing the salary of the people working on the machinery, etc. are successfully overcome there should be considerable savings in departmental execution of such large project.

As regards elimination of contractors the consensus of opinion after discussion was as under :—

“We are already carrying out a lot of works departmentally and without contractors, e.g. most of our earth dams—and these are several—on our irrigation projects. Apart from this, a certain amount of work is being done departmentally both where contractors are not forthcoming as well as elsewhere to give us an idea with reference to quotations of contractors as in the case of tunnelling work at Koyna.

There does not seem to be any scope for disposing with contracting agencies in our present constructional programme to any greater extent than is being practised already. We have a very heavy constructional programme representing several times the size of the programme during First Plan period and it will not be at all practicable to execute it without the help of contractors. Moreover barring the area like Marathwada, where due to lack of development activity in the past no contracting agencies have been developed, the contracting agencies available over the rest of the State are broadly

speaking adequate enough to secure for most ranges of jobs a fair degree of competition. As a result the terms quoted by contractors for this range of works are quite competitive and to do the work departmentally is unlikely to reduce costs; in fact the costs under the departmental construction might be found to be greater in many cases. It is true that so far as very large single works are concerned *e.g.* the Koyna Project Dam or the tunnelling elements in the Koyna Project, etc., or some of our bigger bridges in difficult conditions, etc., the firms capable of tendering for these jobs are only a few and, therefore, the contractor's margins might be considerable. For this class of works also as at present organised, it is not possible for us to dispense with contractors except to a very limited extent. To that limited extent we are already undertaking departmental construction wherever conditions permit.

In this connection, certain important points must be placed on record. For one thing there is no guarantee that departmental construction would be cheaper than that by contractors. For instance, in many cases quotations of the National Construction Corporation recently floated by the Government of India are found to be higher than the rates tendered by contractors. Moreover and more importantly there are certain avoidable and certain unavoidable handicaps about departmental

सत्यमेव जयते

APPENDIX—XI (contd)

work as compared to work undertaken by private contracting agencies. Account rules and audit procedures as at present are a serious limiting factor for undertaking departmental work as they retard speed, prevent quick decisions, etc. Even apart from this and assuming that the remediable deficiencies in the present set of such rules are corrected, it is inevitable that departmental working should labour under certain handicaps. To quote a few instances : To-day when materials, machines and spare parts of machines are all so scarce and difficult to procure, a contractor is able to take rapid action, spot out materials and buy them at 'take over' prices, fly spare-parts, if necessary, by air and so forth; it is inevitable that public authorities, who must necessarily go on record for all their decisions and in respect of whose decisions there would be a careful post-mortem and scrutiny conducted at leisure subsequently would not be able to take decisions with the same rapidity, self confidence and independence of judgement. Very often materials are available only at black market prices or quick transportation can be secured only by underhand means such as graft and bribe; obviously these are outside the pale of any transactions which are required

सत्यमेव जयते

to be brought to book on public accounts. Similarly in the case of technical personnel private contractors have a definite 'edge' on departmental authorities. They are not bound by rules about fixed scales of pay or limitation on advance increments, restrictions as regards unfettered 'hire and fire' of technical personnel and so forth.

Considering all this and circumstances as we are in this State, it is not possible to reduce the field of work for private contractors to any greater extent than at present. We are already taking all the departmental working that we are capable of and designed for doing efficiently and indeed we are taking on a little bit more than this."

24. 8-13 There has been a growing tendency towards curtailment of the powers of the Chief Engineer specially after the separation of the Chief Engineer's post from that of the Secretary to Government. For efficient departmental execution of such large projects, the Chief Engineer should be vested with full powers to give technical sanctions within project provisions, to place orders for plant and machinery required for the project after inviting public tenders, to order spare parts as and when required and to employ work-charged staff on suitable salaries after making detailed provision in the working estimates.

The Chief Engineer, Koyana has been given adequate powers by this Government and no further action appears to be called for.

Many of the present difficulties especially relating to machinery, spare parts, imported elements, etc. are due to the delays and dilatoriness of foreign exchange control. The remedy for these is to be sought elsewhere than in any unsuitable distribution of powers between the Chief Engineer, the Control Board or Government.

The Team's remark is of a general nature. The Team has already noted that conditions in Bombay State are better than in other States in regard to powers of officers. Import license and foreign exchange difficulties need to be solved by the concerned Ministries in Government of India.

COMMENTS OF C.W.& P.C.

M. Hayath
Chairman

D.O.No.CHN/C-6

Central Water and Power Commission,
'Bikaner House',

Dated New Delhi, the 23rd Feb. 1959

My dear Borker,

Please refer to your D.O. No. COPP/I&P/45/58, dated the 14th February, 1959 forwarding a copy of the Irrigation & Power Team's Report on Koyna Project (Bombay State). We have gone through the report and have no particular remarks to offer except the following:—

It is seen that the Team has reassessed the requirements of Power in the area. We must definitely state that the load growth estimated by the Team is very conservative and is not in accordance with conditions governing industrial developments that are taking place in the country. The assessment made by CWPC is by itself quite conservative and our experience has been that the load growth has been much more faster than the Commission has estimated in the past, and there is no reason to believe that it cannot be the case in the area served by the Koyna Project. If augmentation of generating capacity is based on the revised estimate of the Power, conditions of shortage of Power will continue and will be so serious as to jeopardise the industrial growth of the area to be served by the Koyna Project. However, it is gratifying to note that the Team has recommended the implementation of the Second Stage of the Koyna Project as a continuation of the First Stage without any time lag. But, in any case, I would like to place on record that the load growth estimated is far less than what can be considered as definite possibility.

With regard to the points raised on tariff, the Tariff Committee set up by the Koyna Control Board is taking into consideration all the factors that have been mentioned in the report.

Yours sincerely,

Sd/-M.Hayath

Shri D.S. Borker,
Secretary, Consultative Committee,
Irrigation and Power Projects,
Krishi Bhavan, Queen Victoria Road,
NEW DELHI.